

## JRC SCIENCE FOR POLICY REPORT

# Green Public Procurement Criteria for Office Building Design, Construction and Management

*Technical background report  
and final criteria*

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## Abstract

### **Green Public Procurement Criteria for Office Building Design, Construction and Management. Technical background report and final criteria**

The development of Green Public Procurement (GPP) criteria for the design, construction and management of office buildings is aimed at helping public authorities to ensure that projects are procured and implemented in order to deliver environmental improvements that contribute to European policy objectives for energy and resource efficiency, as well as providing healthy working conditions and reducing life cycle costs. In order to identify the most significant improvement areas for criteria development an analysis has been carried out of the environmental and health impacts of constructing and operating office buildings. The most commonly used procurement processes for office buildings, as well as the actors involved in delivering successful projects, have also been identified and are further addressed in an accompanying GPP guidance document. Together these two documents aim to provide public authorities with orientation on how to effectively integrate these GPP criteria into the procurement process.

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# 1 Introduction

Public procurement constitutes (utilities excluded) approx. 14% of overall Gross Domestic Product (GDP) in Europe (EC, 2013) – and thus has the potential to provide significant leverage in seeking to influence the market and to achieve environmental improvements in the public sector.

To reduce the environmental impact of public purchasing, it is important to identify and develop green public procurement (GPP) criteria for products, services and works which account for a high share of public purchasing combined with a significant improvement potential for environmental performance.

The construction and refurbishment of buildings in an energy and resource efficient way is an important policy objective for Europe. The recast *Energy Performance of Buildings Directive*<sup>1</sup>, the *Renewable Energy Directive*<sup>2</sup> and the *Energy Efficiency Directive*<sup>3</sup> together set out requirements for buildings that contribute towards ambitious EU targets for energy efficiency and renewable energy generation by 2020. Moreover, these policy instruments also require the public sector, in the first place through the procurement of refurbishment and new-build projects by central government, to lead the way in delivering efficiency improvements and in deploying cleaner forms of energy generation. The Roadmap to a Resource-Efficient Europe<sup>4</sup> highlighted the significant impact of construction on natural resources. This is further emphasised in the Commission's Communications *Towards a Circular Economy*<sup>5</sup> and *Resource Efficiency Opportunities in the Building Sector*<sup>6</sup> which outline future policy initiatives to address construction and demolition waste.

The development of GPP criteria for office building design, construction and management aims therefore at helping public authorities to ensure that office buildings projects are procured and implemented in order to deliver environmental improvements and with reference to the European policy framework for energy and resource efficiency. In order to identify the most significant improvement areas an analysis is required of the environmental impacts of office buildings. It also requires an understanding of commonly used procurement processes for office buildings and the actors involved in delivering successful projects.

For this reason, the European Commission has developed a process aiming at bringing together both technical and procurement experts to develop a broad body of evidence and to develop in a consensus oriented manner, a proposal for criteria which promise to deliver substantial environmental improvements.

Green Public Procurement (GPP) is a voluntary instrument. The criteria are divided into selection criteria, technical specifications, award criteria and contract performance clauses. For each set of criteria there is a choice between two ambition levels:

- The *Core criteria* are designed to allow for easy application of GPP, focussing on the key area(s) of environmental performance of a product and aimed at keeping administrative costs for companies to a minimum.
- The *Comprehensive criteria* take into account more aspects or higher levels of environmental performance, for use by authorities that want to go further in supporting environmental and innovation goals.

It should be borne in mind that the procurement of office buildings is a particularly complex issue which necessarily results in the fact that, for both core and comprehensive levels of ambition, the inclusion of green criteria does require – when compared to standard solutions – increased expertise, verification effort and, at least for some of the criteria and depending on the procurement route and the experience of the design team and contractors, higher upfront costs.

This Technical Report provides the technical background information and further details on the reasons for selecting the GPP criteria for office buildings. Together with this technical report, the GPP criteria for office buildings are also provided, supported by a guidance document that provides orientation on how to effectively integrate these GPP criteria into the procurement process. These documents represent the latest updated version of the GPP criteria for the office buildings project.

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<sup>1</sup> Directive 2010/31/EC of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (recast)

<sup>2</sup> Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources

<sup>3</sup> Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC, (OJ L 315, 14.11.2012, p. 1)

<sup>4</sup> Communication COM (2011) 571 final

<sup>5</sup> Communication COM (2014) 398 final

<sup>6</sup> Communication COM (2014) 445 final



Publically available information related to the development of the GPP criteria for office buildings can be found at (<http://susproc.jrc.ec.europa.eu/buildings/index.html>) hosted by the Institute for Prospective Technological Studies IPTS.

## 1.1 Scope and definitions of office buildings

This GPP criteria set addresses the procurement process for office buildings, including their design, site preparation, construction, servicing and ongoing management. For the purposes of the criteria, the product group "Office buildings" shall comprise buildings where mainly administrative, bureaucratic and clerical activities are carried out. An office building is, moreover, defined as being:

*"A building whose primary function is to provide space for administrative, financial, professional or customer services. The office area must make up a significant majority of the total building's gross area. The building may also comprise other type of spaces, like meeting rooms, training classrooms, staff facilities, or technical rooms".*

Buildings constituting offices will fall under the specific planning use classes within Member States. The definition of "significant" can vary by Member State, but is generally within a range of 50-80% of the building. The GPP criteria do not cover parking areas that are located outside of the building's physical footprint or curtilage. Major renovations of office buildings are also addressed within the scope of the criteria. Such renovations are defined by the Energy Performance of Buildings Directive 2010/31/EU as instances where:

*a) the total cost of the renovation relating to the building envelope or the technical building systems is higher than 25 % of the value of the building, excluding the value of the land upon which the building is situated; or*

*(b) more than 25 % of the surface of the building envelope undergoes renovation.*

The proposed GPP criteria contain recommendations that apply to both the renovation of existing buildings and the construction of new buildings. They are supported by guidance on supported by guidance on the process of developing and procuring a new or renovated office building. The key stages in this process that are identified in the guidance are as follows:

- Preliminary scoping and feasibility;
- Detailed design and applications for permits;
- Strip-out, demolition and site preparation works;
- Construction of the building or major renovation works;
- Installation of energy systems and the supply of energy services;
- Completion and handover;
- Facilities management;
- Post Occupancy Evaluation.

Energy services are defined according to Directive 2012/27/EC as:

*The physical benefit, utility or good derived from a combination of energy with energy efficient technology and/or with action, which may include the operations, maintenance and control necessary to deliver the service, which is delivered on the basis of a contract and in normal circumstances has proven to lead to verifiable and measurable or estimable energy efficiency improvement and/or primary energy savings.*

For the purpose of the GPP criteria for office buildings, the procurement of energy services is primarily focussing on the supply of low or zero carbon emission energy to an office building by energy service providers such as energy service companies (ESCOs) or, as defined by Directive 2012/27/EC <sup>7</sup>, energy performance contractors (EPCs).

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<sup>7</sup> *ibid* 3

Facilities management is defined according to EN 15221 <sup>8</sup> as:

*'[the] integration of processes within an organisation to maintain and develop the agreed services which support and improve the effectiveness of its primary activities'*

For the purpose of the GPP criteria 'primary activities' refer to operation of the office building with main area of relevance within EN 15221 being 'Space & Infrastructure' which encompasses the activities relating to the management of accommodation, workplaces, technical infrastructure and ICT systems.

In general, the criteria focus on an office building as a system rather than individual components. It should be noted that separate GPP criteria are available that can be used for the procurement of various building components. At the time of writing, components of relevance for which there exist EU GPP criteria <sup>9</sup> include:

- Wall panels,
- Combined Heat and Power (CHP) systems,
- Water-based heating systems,
- Indoor lighting,
- Taps and showerheads,
- Toilets and urinals.

## 1.2 Market analysis

Office building data in EU-28 are not official and rarely harmonised between countries. In the preliminary background report, a detailed market analysis was carried out for office buildings across Europe<sup>10</sup>. Aggregated market data was presented. It should however be remembered that limitations in the transparency of the EU statistics and lack of data in general resulted in a number of assumption having to be made. In order to supplement and update this data, a review has been made of selected reports by the property market analysts BNP-Paribas, DTZ, Jones Lang La Salle and Savills.

The non-residential building stock accounts for approximately 25% of the total floor area, and of this proportion 23% is represented by office buildings (approximately 6% of the total building stock floor area) <sup>11</sup>. The majority of these consist of large office buildings, mainly erected before 1975 and concentrated in moderate climatic zones. These comprise Austria, Belgium, Czech Republic, Denmark, France, Germany, Hungary, Ireland, Luxembourg, Netherlands, Slovakia, Slovenia and UK. .

The construction sector is split into two main categories: buildings and civil engineering work. The data presented in Figure 1.1 shows that "production for construction" in Europe was in 2013 at its lowest level during the last 14 years because of the ongoing economic downturn <sup>12</sup>. The office sector has been one of the first to show some tentative signs of recovery, as illustrated by Figure 1.2 which shows trends in development completions, and there have also been signs of a reduction in office vacancy rates <sup>13</sup>. However, due to intensive fiscal austerity policies adopted by some countries, it has to be expected that direct investment and subsidies from governments and public authorities to promote green buildings will be limited in the coming years.

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<sup>8</sup> EN 15221 series, *Facility management*, October 2006 version

<sup>9</sup> See [http://ec.europa.eu/environment/gpp/eu\\_gpp\\_criteria\\_en.htm](http://ec.europa.eu/environment/gpp/eu_gpp_criteria_en.htm)

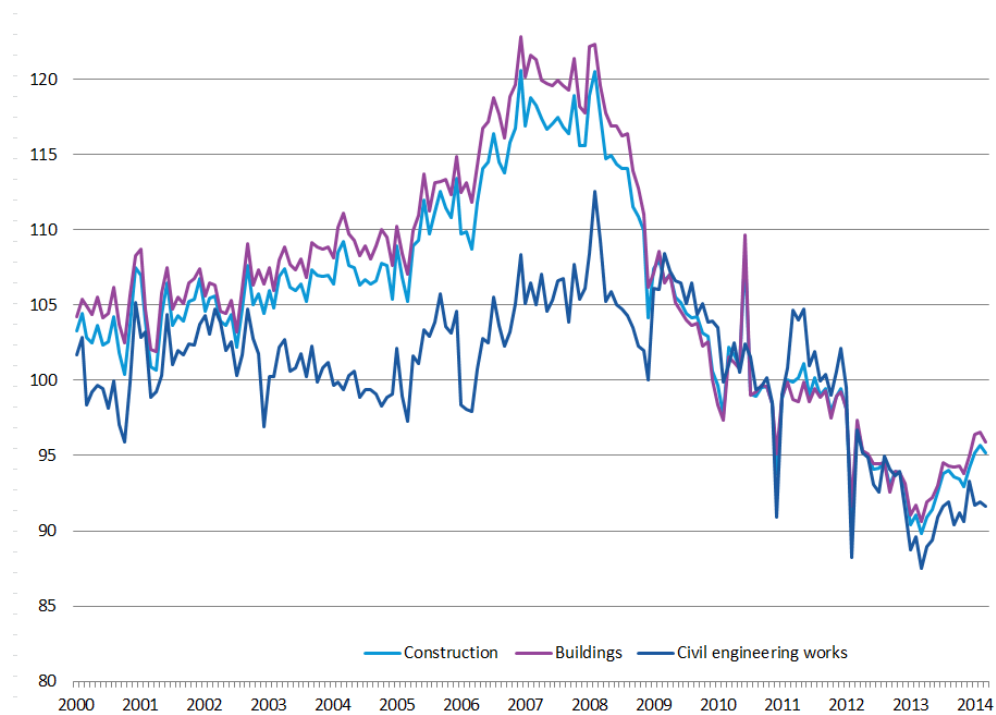
<sup>10</sup> European Commission, *GPP Office buildings: Economical and market analysis*, JRC-IPTS 2011  
<http://susproc.jrc.ec.europa.eu/buildings/docs/market%20and%20economic%20analysis.pdf>

<sup>11</sup> Building Performance Institute Europe, *Europe's buildings under the microscope*, October 2011

<sup>12</sup> Eurostat (2014). *Construction production (index) overview*, Available online at

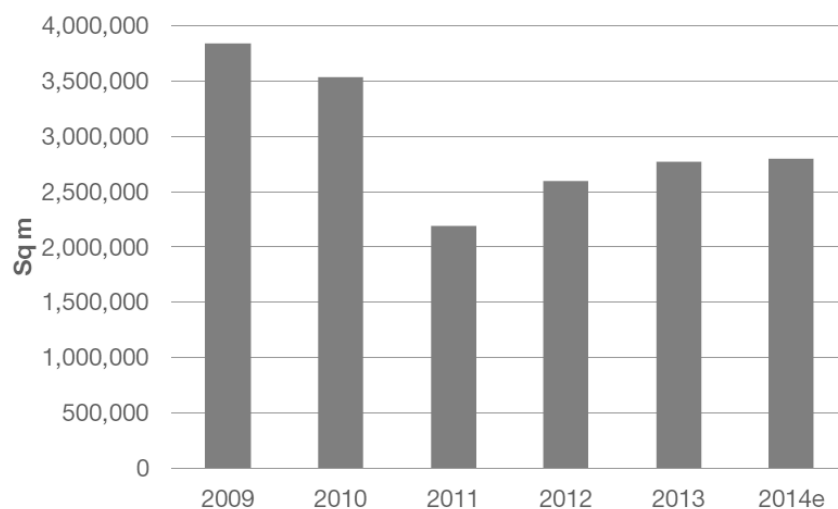
[http://epp.eurostat.ec.europa.eu/statistics\\_explained/index.php/Construction\\_production\\_\(volume\)\\_index\\_overview](http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Construction_production_(volume)_index_overview)

<sup>13</sup> Savills, *Market report: European offices*, March 2014



Source: Eurostat (2014)

**Figure 1.1 Index of price adjusted construction output, EU-28, 2000-14**



Source: Savills (2014)

**Figure 1.2: Office development completions in Europe**

#### *Public sector activity*

Public construction activity was, until the onset of the economic downturn, an important factor in the market. Prior to the downturn EU-27 expenditure in construction and housing accounted for 1.4% of GDP (3.0% of government expenditure). Often public authorities try to fight economic downturns through public investments which, for example, can include public construction procurement. However, the possibilities to do so depend on budgetary constraints. Indicative figures for the percentage of office buildings attributed to central government and municipalities for some EU-27 countries include Germany (20%), France (30%),

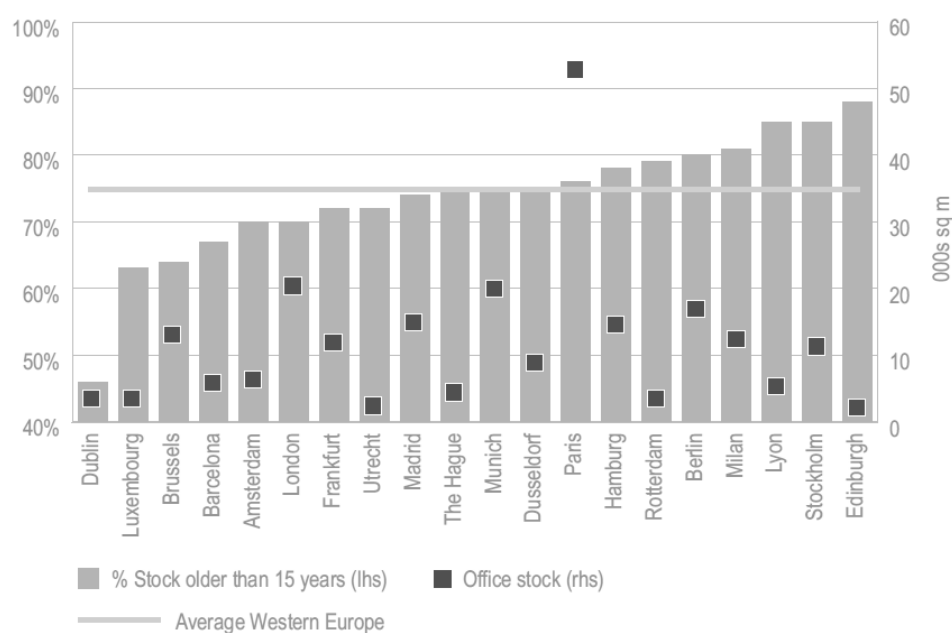
Austria (17%) and Finland (11%). These proportions are expected to fall in the future as cuts in the public sector lead to a rationalisation in the stock and more efficient space utilisation in the retained stock.

As a result, following the EU's debt crisis, some countries have followed intensive fiscal austerity policies and EU's Finance Ministers approved a comprehensive rescue package worth almost a trillion dollars aimed at ensuring financial stability across Europe by creating the European Financial Stability Facility. Only when economic recovery occurs and the crisis of confidence is over, will the amount of money spent on both construction and environmental policy will be the one observed in the years before the financial crisis. Moreover, it can be seen that subsidies from governments to promote green buildings have been reduced, so even though environmental policies have not lost relative importance, their importance has reduced in absolute budgetary terms.

#### *The increasing importance of renovation*

As can be seen in Figure 1.3, the majority of Europe's office building stock is dated. For example, in Germany 59% of the stock dates from between 1950 and 1990 and in the UK 22% dates from before 1960. With the continued economic downturn there has been on average a lower rate of replacement of offices across Europe, cited as being between 1% and 3%<sup>14</sup>. This means that as the building stock ages the cost of maintaining this stock will increase for both investors and occupiers.

As a result of the economic crisis an increased focus has been observed on better use of existing building assets, and this is reflected by a wider trend in EU office markets for major renovations instead of new-build projects. A trend has also been noted towards more efficient use of space, with reductions in both office footprints and space per workstation <sup>15</sup>.



Source: Jones Lang La Salle (2013) lhs=left axis rhs=right axis

**Figure 1.3. Proportion of office building stock older than 15 years across Western Europe**

## **1.3 The environmental impacts of office buildings**

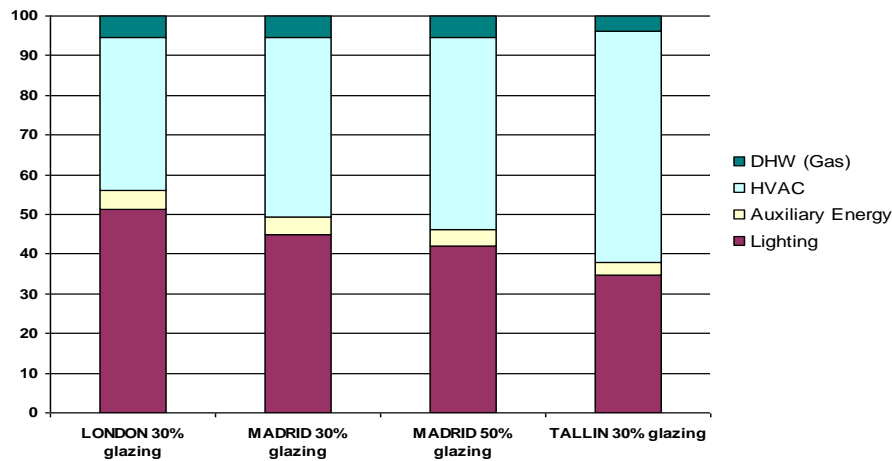
Broad evidence for the life cycle environmental impacts of office buildings across the different European climatic zones indicates that energy use during their occupation is related to the most significant impacts<sup>16</sup>. In detail, for the purpose of the project, one generic office building with flexible parameters and with a life span ranging over 50 years was analysed by means of an LCA. One of the main outcomes is referred to the

<sup>14</sup> Jones Lang La Salle (2013) *From obsolescence to resilience*, UK

<sup>15</sup> DTZ Research (2012) *Occupier perspective series*, Quarterly reporting series

<sup>16</sup> European Commission, *GPP Office buildings: Technical Background report*, JRC-IPTS 2011

energy consumption during the use phase. Of the primary energy used during occupation the most significant contributors tend to be lighting, heating, cooling and ventilation. Their relative importance can be seen to vary according to the age of the building, its thermal insulation as well as the climatic zone in which the building is located. This highlights the importance of taking into account the overall energy performance of a building, which could include the potential to generate cleaner energy. In Figure 1.4 an example of the total energy consumption evaluation for different buildings located in different climatic zones has been reported.



**Figure 1.4. . Energy consumption distribution of an office building during the use phase <sup>17</sup>**

The Energy Performance of Buildings Directive has led to the adoption of stricter regulations on energy use at Member State level<sup>18</sup>. Office buildings have, as a result, become more energy efficient and the significance of space heating, particularly in northern Europe, has tended to reduce. Space heating requirements are, however, still significant in older office buildings, which may therefore be candidates for major renovation. Cooling has become more significant, particularly in warmer climates, because of the increased use of computers and the installation of larger IT servers which generate waste heat. Intelligent lighting controls have allowed for lighting systems to become more responsive to occupancy and daylighting levels, thereby saving electricity. The thermal efficiency of the building fabric, building orientation and façade configurations, water use, together with a buildings depth and layout, all play a role in influencing heating, cooling, lighting and ventilation requirements in existing buildings<sup>19</sup>.

As office buildings have become overall more energy efficient, this has at the same time resulted in an increase in the importance of environmental impacts associated with their construction. The use of more energy intensive insulation materials and façade systems in order to meet higher energy efficiency standards has, for example, tended to increase the overall environmental impact of the construction materials used<sup>20</sup>, although an increasing focus on evaluation of so-called embodied energy and CO<sub>2</sub> is focussing the attention of design teams on solutions that can minimise construction impacts.

The production of construction products is responsible for the next most significant environmental impacts. These relate to the resources used and the energy use, emissions and ecosystem impacts associated with raw material extraction, processing and transportation. Resource use is influenced by the amount of waste generated during product manufacturing, construction on-site and demolition processes, which can be significant as a proportion of the overall material flows on a construction site. This highlights the importance of designing and specifying for resource efficiency, with the most significant building elements to address being the floors, roof, structure and external walls. In this respect the recycling and re-use of construction materials and products, as well as whole building elements, can contribute to reducing environmental impacts and development of a circular economy.

<sup>17</sup> DHW, Domestic Hot Water; HVAC, Heating, Ventilation and Air Conditioning

<sup>18</sup> European Commission, *Energy efficiency: Buildings*, DG Energy, [http://ec.europa.eu/energy/efficiency/buildings/buildings\\_en.htm](http://ec.europa.eu/energy/efficiency/buildings/buildings_en.htm)

<sup>19</sup> Baker, N & K, Steemers (1999) *Energy and environment in design: A technical design guide*, Taylor and Francis.

<sup>20</sup> Sartori, I. and A.G. Hestnes. *Energy use in the life cycle of conventional and low-energy buildings: a review article*, *Energy Build*, 2007, 39(3):249–57.

A related consideration in the case of large-volume, high-weight construction materials are impacts relating to the transportation of aggregates (natural, recycled or secondary) to production sites. Transport of these materials is generally by lorry, which results in fuel-related emissions that are generally greater than or equal to those for the production of such materials. If these materials are moved over distances greater than 25 km, then the resulting emissions can contribute significantly to the environmental impacts of the production phase for the main building elements. Minimising transport-related emissions can help to promote the use of lower impact modes of transport such as rail or shipping for these materials. Finally, the use of recycled materials such as aggregates from construction and demolition waste can help develop a market for such materials, in line with EU Circular Economy objectives, and provide associated resource efficiency benefits.

A further factor to consider is the lifespan of the building and its elements, which is also sometimes referred to as its service life, and related to this its functionality as a healthy working environment. As a general rule, the longer the lifespan of the main structural elements of the building, the lower their associated life cycle environmental impacts, assuming that the overall energy performance is also prioritised as part of the overall approach during the service life. Along the same lines, design to facilitate the adaptation of a building and its structure once it has reached the end of its service life for the contracting authority is an important consideration in seeking to extend a buildings lifespan.

The integration of nature-based solutions, such as green roofs and walls, habitats in courtyards and patios, Sustainable Urban Drainage Systems (SUDS) as part of landscaping and street trees can have multiple advantages (in addition to supporting biodiversity). These can include limiting rain-water run-off, improving thermal efficiency through natural cooling, enhancing indoor air quality and making the working environment more attractive and productive. Biophilia – an intrinsic human need to have access to nature – is increasingly recognised as an important aspect of building and urban design.

Whilst these GPP criteria are mainly focussed on environmental impacts related to the building itself, it is important to recognise the significant wider 'induced' environmental impacts generated by travel to and from the workplace. Emissions to air arise from the use of fossil fuels such as diesel and petrol, and have both localised and global environmental impacts. Emissions to air can be reduced by locating and designing office buildings in order to promote the use of more sustainable modes of transport, to include cycling and walking, public transport, low emissions vehicles and car sharing.

Other factors relating to occupation of an office building can also influence the long term value of an office building. For example, a healthy and attractive working environment can contribute to a longer service lifespan and minimise the need for renovations. Evidence also shows that in a healthy building the workforce is more productive and there are less illness-related absences <sup>21</sup>.

The key environmental areas to be addressed, as well as the key life cycle environmental impacts, are summarised below. Based on the background evidence analysed during the criteria development process, the overall GPP approach and focus for office buildings has also been summarised.

### **Key Environmental Areas in an Office Buildings' life cycle and Key Environmental Impacts**

#### **Key environmental areas**

- Primary energy consumption and associated greenhouse gas emissions during use of and travel to and from the building
- Depletion of natural resources, embodied energy and emissions associated with the manufacturing and transportation of building materials
- Waste generation during site preparation, construction, use and demolition of the building
- Deterioration in indoor air quality due to emissions of hazardous substances from building products and the intake of particulate air pollution from the external environment
- Pollution of the local environment and deterioration of local air quality due to emissions from vehicles used to travel to and from the building
- Water consumption during use of the building

<sup>21</sup> Useable Buildings Trust, *PROBE post occupancy study series*, Building Services Journal 1995-2002, <http://www.usablebuildings.co.uk/>

Key life cycle environmental impacts and parameters for resource use:

- The following environmental impact categories along the product life cycle are considered to be the most important ones: global warming potential, acidification, exploitation of renewable and non-renewable primary energy resources, eco-toxicity, human toxicity, eutrophication, abiotic resource depletion, water consumption, use of secondary and re-used materials and waste material flows.

#### **Proposed EU GPP Office Buildings approach**

- Design and construction to achieve high energy efficiency performance and low associated CO<sub>2</sub> emissions
- Installation of high efficiency and renewable energy technologies which make use of site-specific opportunities to reduce energy consumption and CO<sub>2</sub> emissions
- Design and specification to reduce the embodied impacts and resource use associated with construction materials
- Design, specification and site management to minimise construction and demolition (C&D) waste and to use building products or materials with a high recycled or re-used content
- Specification of fit-out and finishes that minimise hazardous emissions to indoor air
- Ventilation design in order to ensure healthy air and minimise the intake of external air pollution
- Specification and installation of water saving technologies
- Installation of physical and electronic systems and technologies to support the ongoing minimisation of energy use, water use and waste arisings by facilities managers and occupiers
- Implementation of staff travel plans to reduce transport related fuel use and CO<sub>2</sub> emissions, including infrastructure to support electric vehicles and cycling.

## 1.4 GPP criteria for office buildings

For better readability of this document, a list of the proposed GPP criteria for office buildings with a brief description of the contents is summarised below. Not all of the criteria will be relevant for all projects and forms of contracts. Unless otherwise noted in brackets the criteria areas are relevant to both Core and Comprehensive criteria.

GPP criterion	Brief Description
<b>Criteria related to the ability of the tenderer</b>	
Competencies of the project manager	<i>Experience and expertise in the management of:</i> <ul style="list-style-type: none"> <li>- Contracts with environmental performance requirements</li> <li>- Implementation of environmental technologies and design innovations</li> <li>- Financial appraisal of environmental technologies and design innovations</li> </ul>
Competencies of the design team	<i>Experience and expertise in:</i> <ul style="list-style-type: none"> <li>- Energy efficient building fabric and services design and commissioning</li> <li>- Specification of resource efficient construction materials.</li> <li>- Use of multi-criteria building assessment and certification schemes,</li> </ul>
Competencies of the lead construction contractor and specialist contractors	<i>Experience and expertise in:</i> <ul style="list-style-type: none"> <li>- Energy efficient building fabric and services design and commissioning</li> <li>- Procurement of resource efficient construction materials.</li> <li>- Implementation of demolition site waste management plans</li> </ul>
Competencies of design, build and operate (DBO) contractors and property developers	<i>Experience and expertise in the selection and management of:</i> <ul style="list-style-type: none"> <li>- Design teams to achieve environmental performance requirements</li> <li>- Main contractors who have delivered buildings with environmentally improved performance</li> <li>- Ongoing facilities management in order to optimise the performance of office buildings</li> </ul>
<b>Criteria related to different environmental aspects of the building</b>	
<b>Energy-related criteria</b>	
<b>Energy performance</b>	
Minimum energy performance	- Achieving Cost-Optimal performance with rewards of a further reduced energy consumption as award criterion
Commissioning of building energy systems	- By reference to EN, ISO or equivalent standards for systems
Quality of the completed building fabric	- Thermal imaging (Core) and air tightness testing (Comprehensive)
<b>Lighting</b>	
Lighting control systems	- Requiring features not addressed in national energy calculation methodologies
Commissioning and handover of lighting control systems	- Manual, training and Building Energy Management System interface
<b>Building Energy Management System (BEMS)</b>	
BEMS installation	- Intelligent systems and data collection
Commissioning and handover of the BEMS	- By reference to EN, ISO or equivalent standards for systems - Manual, training and use of user interface
<b>Low or zero carbon energy sources</b>	
Energy supply systems	- Highly efficient or renewable sources with rewards for a higher share of sustainable supply sources as award criterion
Commissioning of energy supply systems	- Connection and commissioning
Heating systems including CHP	- Reference to EU GPP criteria for CHP and water-based heaters
<b>Facilities energy management</b>	
Reporting on energy use	- Monthly data collection and reporting
Performance-based energy contracting	- Limits on energy consumption associated with lighting, heating, cooling, ventilation and auxiliary power



<b>Resource efficient construction</b>	
<b>Life cycle performance</b>	
Performance of the main building elements	- <i>Two options based on EPDs and/or LCA results</i>
<b>Construction product recycled content</b>	
Incorporation of recycled content	- <i>15% (Core) and 30% (Comprehensive)</i>
<b>Wood sourcing</b>	
Legal sourcing of wood construction materials	- <i>Due diligence along the supply chain</i>
<b>Waste management plans</b>	
Demolition waste audit and management plan	- <i>55% (Core) and 70% (Comprehensive) by weight</i> - <i>Structure and fit-out elements</i> - <i>Hazardous waste risk assessment</i> - <i>Bill of quantities and methods for recycling and re-use</i> - <i>On-site monitoring and accounting</i>
Site waste management plan	- <i>11 tonnes (Core) and 7 tonnes (Comprehensive) per 100 m<sup>2</sup> floor area</i>
<b>Other environmental criteria</b>	
<b>Recycling facilities</b>	
Recyclable waste storage provision	- <i>Designation of space in the design</i> - <i>Detailed plans of facilities</i>
Waste management system	- <i>Basic segregation systems with monitoring and reporting of arisings</i>
<b>Water saving</b>	
Water saving installations	- <i>Link to other EU GPP criteria sets</i>
<b>Quality of the office environment</b>	
<b>Thermal comfort conditions</b>	- <i>Maximum/minimum temperatures</i>
<b>Daylighting and glare</b>	- <i>Dynamic modelling of illuminance and glare</i>
<b>Air quality</b>	
Ventilation and air quality	- <i>Clean air intake and filtration</i>
Selection of fit-out materials and finishes	- <i>Testing to minimise emissions of VOC's, SVOC's and carcinogens</i>
Air quality testing	- <i>In-situ sample testing for VOC's, formaldehyde and particulates</i>

## 1.5 Applicability of the Green Public Procurement criteria for office buildings

Designing and procuring an office building with a reduced environmental impact, whether it be new-build or a major renovation, is a complex process. Considering the complexity of the office building procurements, a guidance document has been developed to provide procurers with orientation on how to effectively integrate the GPP criteria for office buildings into the procurement process (see Section 3).

The process of constructing a new office building or carrying out a major office renovation consists of a distinct sequence of procurement activities with related contracts. This sequence of procurement can have a significant influence on the outcome. This is because each type of contract brings with it distinct interactions between the procurer, the building design team, the contractors and the future occupants and facilities managers. Moreover, they each have advantages and disadvantages in seeking to procure an improved environmental performance.

Depending on the procurement route adopted, some of these contracts may be awarded to the same contractor but in most cases they are let separately. Some contracts may be integrated in a design and build (DB) or a design, build and operate (DBO) arrangement, with the detailed design process, the main construction contract, the installation or provision of energy services and even facilities management all potentially co-ordinated by one contractor.

It is therefore important to identify the main points in the sequence of procurement activities where GPP criteria should be integrated. To this end these criteria are accompanied by a guidance document which provides general advice on how and when GPP criteria can be integrated into this process. It also suggests, based on experience from different projects across the EU, how the procurement sequence could be managed in order to achieve the best results.

The following stages in the procurement process for a new or renovated office buildings are covered by the criteria, having been identified as stages where formal procurement will take place or requires monitoring:

- A. Selection of the design team and contractors
- B. Detailed design and performance requirements
- C. Strip-out, demolition and site preparation works
- D. Construction of the building or major renovation works
- E. Installation of energy systems or the supply of energy services
- F. Completion and handover
- G. Facilities management

Depending on the ambition level of the project and the experience of the contracting authority, not all of the GPP criteria included in this criteria set will be relevant. Moreover, depending on the preferred procurement sequence criteria may be best addressed at specific stages. Some activities may be let as separate contracts requiring their own criteria.

The strategic objectives and targets of the project should be determined at the outset of the project with reference to the GPP criteria set. The optimum stages for integration of GPP criteria should be evaluated during discussions to determine the procurement route. In all cases it is strongly recommended that GPP criteria are integrated into both internal planning and the procurement sequence at as early a stage as possible in order to secure the desired outcomes and achieve the best value for money.

## 2 GPP final criteria

This section provides the technical evidence and rationale for each of the final GPP criterion. The criterion are grouped into the following broad criteria areas:

- Project team competencies
- Energy-related criteria
- Resource efficient construction criteria
- Other environmental criteria
- Office environmental quality criteria

For each criteria area technical and market evidence is presented and discussed. Draft criteria proposals are then proposed, split into Core and Comprehensive technical specifications, Award criteria and (where appropriate) Contract Performance Clauses.

### 2.1 Project team competencies

The selection criteria have been specified to encompass the range of competencies and expertise that would be required to deliver an environmentally improved office building. These reflect the need for experience in specific technical areas as well as in the successful management of technical innovation in this field.

The first two proposed criteria are focussing on the project manager and the design team, who have a critical role to play in selecting, modelling, specifying and integrating solutions to meet environmental criteria. Working alongside the design team, the role of the project manager was identified by stakeholders as being significant in managing technical innovation, so it is specifically highlighted. Given the increasing prevalence of building environmental assessment schemes, experience and expertise in applying them to projects is also judged to be of value in managing a design teams' response to a range of environmental criteria.

The next two criteria are focussing on the main building contractor and possible specialist contractors, as well as potential Design, Build and Operate (DBO) contractors and property developers. The need to make the distinction between these two broad types of contractors was highlighted by stakeholders because of the difference in the contractual relationships and competencies required. Depending on the nature of the project, it may also be necessary to procure the services of specialist contractors. These could include, for example, the demolition of buildings already on a site or an Energy Service Company (ESCo) providing building renovations and/or low or zero carbon energy supply technologies.

#### **Stakeholder feedback received during the final written consultation**

It was commented that the roles of the project manager and the design team should be separated. They are distinct competencies and the project managers may be separately contracted from the design team. The same should also apply to the competencies of the main contractor and property developers, which should be distinguished.

With reference to the overall management of energy use, the potential to refer to ISO 50001 was highlighted by one stakeholder. This is a standard that specifies the elements of an energy management system.

Moreover, a stakeholder also commented that the criteria should include reference to experience in the design/construction of buildings with the same procured scale/budget.

*These comments are addressed in the above-given background discussion and rationale.*

*Selection criteria on the competencies of the project manager and design team*

Core criteria	Comprehensive criteria
<b>SELECTION CRITERIA</b>	
<p><i>These criteria may form part of a pre-selection procedure where the services of a project manager and/or a design team are procured by the contracting authority. The number and size of executed projects to prove the experience should be proportionate to the tendered project. Design competitions may be used to encourage new companies with less experience to bid, although to balance the risk it could be requested that the design team contains experienced supporting expertise.</i></p>	
<p><b>A1. Competencies of the project manager</b></p> <p>The project manager shall have relevant competencies and experience in each of the following areas for which they would be responsible under the contract (<i>select as relevant to the specific contract</i>):</p> <ul style="list-style-type: none"> <li>- The project management of building contracts that have met or exceeded the environmental performance requirements set by clients;</li> <li>- The successful identification and management of the delivery of a range of environmental technologies and design innovations required to deliver improved environmental performance and quality;</li> <li>- Involvement in the financial appraisal of environmental technologies and design innovations as part of the delivery of projects.</li> </ul> <p><b>Verification:</b></p> <p>Evidence in the form of information and references related to relevant contracts in the previous 5 years in which the above elements have been carried out. This shall be supported by CVs for personnel who will work on the project.</p>	<p><b>A1. Competencies of the project manager</b></p> <p>The project manager shall have relevant competencies and experience in each of the following areas for which they would be responsible under the contract (<i>select as relevant to the specific contract</i>):</p> <ul style="list-style-type: none"> <li>- The project management of building contracts that have met or exceeded the environmental performance requirements set by clients;</li> <li>- The successful identification and management of the delivery of a range of environmental technologies and design innovations required to deliver improved environmental performance and quality;</li> <li>- Involvement in the financial appraisal of environmental technologies and design innovations as part of the delivery of projects;</li> <li>- Projects that included the assessment of building environmental performance using multi-criteria building assessment, reporting and certification schemes;</li> <li>- The use of holistic assessment tools in the design, appraisal and specification of environmentally improved buildings, including LCC and LCA.</li> </ul> <p><b>Verification:</b></p> <p>Evidence in the form of information and references related to relevant contracts in the previous 5 years in which the above elements have been carried out. This shall be supported by CVs for personnel who will work on the project.</p>
<p><b>A2. Competencies of the design team</b></p> <p>The architect, consultant and/or design team consortium shall have relevant competencies and experience in each of the following areas for which they would be responsible under the contract (<i>select as relevant to the specific contract</i>):</p> <ul style="list-style-type: none"> <li>- The management of building contracts that have delivered improved environmental performance that goes beyond minimum building-code requirements (<i>specify if national, regional, local or other</i>) regarding the following aspects (<i>to be completed with elements deemed important by the contracting authority and not covered below</i>);</li> <li>- Energy efficient building fabric and services design for new-build or renovation projects (<i>select as appropriate</i>), including if available measured energy performance data per m<sup>2</sup> from completed projects including heating, cooling, lighting, hot water and auxiliary equipment;</li> <li>- Installation of Building Energy Monitoring Systems (BEMS), communication of how they work to building managers and their use to diagnose energy use patterns in</li> </ul>	<p><b>A2. Competencies of the design team</b></p> <p>The architect, consultant and/or design team consortium shall have relevant competencies and experience in each of the following areas for which they would be responsible under the contract (<i>select as relevant to the specific contract</i>):</p> <ul style="list-style-type: none"> <li>- The management of building contracts that have delivered improved environmental performance that goes beyond minimum building-code requirements (<i>specify if national, regional, local or other</i>) regarding the following aspects (<i>to be completed with elements deemed important by the contracting authority and not covered below</i>);</li> <li>- Energy efficient building fabric and services design for new-build and/or renovation projects (<i>select as appropriate</i>), including if available measured energy performance data per m<sup>2</sup> from completed projects including heating, cooling, lighting, hot water and auxiliary equipment;</li> <li>- The specification and design of renewable and/or high</li> </ul>

<p>buildings;</p> <ul style="list-style-type: none"> <li>- Water efficient services design, including measured water demand per employee from completed projects;</li> <li>- The specification, procurement and installation of low environmental impact construction materials. To include reference to EPDs in compliance with ISO 14025 or EN 15804;</li> <li>- The development and implementation of staff travel plans, including infrastructure for low emission vehicles and bicycles.</li> </ul> <p>Project experience and Continuous Professional Development (CPD) of relevance to these areas shall be highlighted.</p> <p><i>The contracting authority may require a minimum number of contracts according to the nature of the project.</i></p> <p><b>Verification:</b></p> <p>Evidence in the form of information and references related to relevant contracts in the previous 5 years in which the above elements have been carried out. This shall be supported by CVs of personnel who will work on the project.</p>	<p>efficiency energy generation equipment;</p> <ul style="list-style-type: none"> <li>- Installation of Building Energy Monitoring Systems (BEMS), communication of how they can be used to building occupiers and their use to diagnose energy use patterns in buildings;</li> <li>- Water efficient services design, including measured water demand per employee from completed projects;</li> <li>- Bioclimatic architecture and passive design to good thermal and optical comfort, natural air purification etc;</li> <li>- Assessment of building environmental performance using multi-criteria building assessment and certification schemes,</li> <li>- The specification, procurement and installation of low environmental impact construction materials. To include reference to EPDs in compliance with ISO 14025 or EN 15804.</li> <li>- The use of holistic assessment tools in the design and specification of environmentally improved buildings including LCC and LCA. Comparative studies in compliance with ISO 14040/14044 or EN 15978.</li> <li>- Design, specification and monitoring to address daylighting and glare, thermal comfort and indoor air quality</li> <li>- The development and implementation of staff travel plans, including infrastructure for low emission vehicles and bicycles.</li> </ul> <p>Project experience and Continuous Professional Development (CPD) of relevance to these areas shall be highlighted.</p> <p><i>The contracting authority may require a minimum number of contracts according to the nature of the project.</i></p> <p><b>Verification:</b></p> <p>Evidence in the form of information and references related to relevant contracts in the previous 5 years in which the above elements have been carried out. This shall be supported by CVs of personnel who will work on the project.</p>
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*Selection criteria on the competencies of the lead construction contractor, specialist contractors and/or property developers*

Core criteria	Comprehensive criteria
SELECTION CRITERIA	
<p><b>A3. Competencies of the main construction contractor and specialist contractors.</b></p> <p><i>These criteria may form part of a pre-selection procedure for the main contractor or where specialist contractors are to be procured e.g. demolition, ESCOs.</i></p> <p>The construction contractor shall have relevant competencies and experience in the completion of building contracts that have been shown to have delivered improved environmental performance.</p>	<p><b>A3. Competencies of the main construction contractor and specialist contractors.</b></p> <p><i>These criteria may form part of a pre-selection procedure for the main contractor or where specialist contractors are to be procured e.g. demolition, ESCOs.</i></p> <p>The construction contractor shall have relevant competencies and experience in the completion of building contracts that have been shown to have delivered improved environmental performance.</p>

<p>In the case of design and build contracts, criterion A1 will also be relevant to the design team employed.</p> <p>Relevant areas of experience shall include (as appropriate to the project and the selected GPP criteria):</p> <ul style="list-style-type: none"> <li>- Energy efficient building fabric and services design for new-build or renovation projects (<i>select as appropriate</i>), including if available measured energy demand per m<sup>2</sup> from completed projects including heating, cooling, lighting, hot water and auxiliary equipment. This will have been applied in the context of new-build and/or renovation projects (select as appropriate);</li> <li>- The installation of Building Energy Monitoring Systems (BEMS) and communication of how they work to building managers;</li> <li>- The installation of water efficient services, including if available measured water demand per employee from completed projects;</li> <li>- The procurement, installation and verification of low environmental impact construction materials.</li> <li>- The successful implementation of demolition and site waste management plans in order to minimise waste arisings. Selection and knowledge of off-site treatment options.</li> </ul> <p><b>Verification:</b></p> <p>Evidence in the form of information and references related to relevant contracts in the last 5 years in which the above elements have been carried out. This shall also be supported by CVs for personnel who will work on the project and their relevant project experience.</p>	<p>In the case of design and build contracts criteria A1 will also be relevant to the design team employed.</p> <p>Relevant areas of experience shall include (as appropriate to the project and the selected GPP criteria):</p> <ul style="list-style-type: none"> <li>- Energy efficient building fabric and services design, including if available measured energy demand per m<sup>2</sup> from completed projects including heating, cooling, lighting, hot water and auxiliary equipment. This will have been applied in the context of new-build and/or renovation projects (select as appropriate);</li> <li>- The installation, commissioning and (as relevant) ongoing operation/maintenance of renewable and/or high efficiency energy generation equipment;</li> <li>- The installation of Building Energy Monitoring Systems (BEMS) and communication of how they work to building managers;</li> <li>- The installation of water efficient services, including if available measured water demand per employee from completed projects;</li> <li>- Functioning passive design features to achieve low energy use and good thermal and optical comfort, etc; as evidenced by post-occupancy studies;</li> <li>- The procurement, installation and verification of low environmental impact construction materials. Supply chain management to ensure compliance with building assessment and certification systems and in order to support modelled resource efficiency strategies;</li> <li>- The successful implementation of demolition site waste management plans in order to minimise waste arisings. Selection and knowledge of off-site treatment options.</li> <li>- The installation of features to address daylighting and glare, thermal comfort and indoor air quality</li> </ul> <p><b>Verification:</b></p> <p>Evidence in the form of information and references related to previous contracts in the last 5 years in which the above elements have been carried out. This shall be supported by evidence and data from:</p> <ul style="list-style-type: none"> <li>- Third party auditing,</li> <li>- Post-occupancy auditing,</li> <li>- LCA/LCC analysis and/or</li> <li>- Data collection from monitoring</li> </ul> <p>This shall also be supported by CVs for personnel who will work on the project and their relevant project experience.</p>
<p><b>A4. Competencies of DBO contractors and property developers</b></p> <p><i>These criteria may form part of a pre-selection procedure for the DBO contractor or property developer that will operate the building.</i></p> <p><i>The contractor shall have relevant competencies and experience in managing the construction and operation of office buildings that have been shown to have delivered improved environmental performance. Criterion A1 will also be relevant to the design team employed.</i></p>	<p><b>A4. Competencies of DBO contractors and property developers</b></p> <p><i>These criteria may form part of a pre-selection procedure for the DBO contractor or property developer that will operate the building.</i></p> <p><i>The contractor shall have relevant competencies and experience in managing the construction and operation of office buildings that have been shown to have delivered improved environmental performance. Criterion A1 will also be relevant to the design team employed.</i></p>

<p>Relevant areas of experience shall include (as appropriate to the project and the selected GPP criteria):</p> <ul style="list-style-type: none"> <li>- The management of design teams to achieve the permitting and construction of office buildings that met client performance requirements, including under DBO arrangements;</li> <li>- The management of main contractors for the construction of office buildings that have environmentally improved performance, including under DBO arrangements;</li> <li>- Ongoing facilities management in order to optimise the performance of office buildings, including the use of systems such as BEMS, the contracting of energy managers and the ongoing monitoring/reporting on performance;</li> </ul> <p><b>Verification:</b></p> <p>Evidence in the form of information and references related to previous projects and contracts in the last 5 years in which the above elements have been carried out. This shall also be supported by CVs for personnel who will work on the project and their relevant project experience.</p>	<p>Relevant areas of experience shall include (as appropriate to the project and the selected GPP criteria):</p> <ul style="list-style-type: none"> <li>- The management of design teams to achieve the permitting and construction of office buildings that met client performance requirements, including under DBO arrangements;</li> <li>- The management of main contractors for the construction of office buildings that have environmentally improved performance, including under DBO arrangements.;</li> <li>- The management of design teams and/or main contractors to obtain ratings according to multi-criteria building assessment and certification schemes;</li> <li>- Ongoing facilities management in order to optimise the performance of office buildings, including the use of systems such as BEMS, the contracting of energy managers and the ongoing monitoring/reporting on performance;</li> </ul> <p><b>Verification:</b></p> <p>Evidence in the form of information and references related to previous projects and contracts in the last 5 years in which the above elements have been carried out. This shall also be supported by CVs for personnel who will work on the project and their relevant project experience.</p>
<p><b>A5. Energy Management System</b></p> <p><i>These criteria may form part of a pre-selection procedure for a developer/operator of the office building.</i></p> <p>The DBO contractor or property developer who will operate the building shall be able to demonstrate experience in implementing energy management systems for sites, such as ISO 50001 or equivalent, as part of facilities management arrangements.</p> <p><b>Verification:</b></p> <p>The DBO contractor or property developer shall provide management system certifications for sites they operate or have operated over the last three years.</p>	<p><b>A5. Energy Management System</b></p> <p><i>These criteria may form part of a pre-selection procedure for a developer/operator of the office building.</i></p> <p>The DBO contractor or property developer who will operate the building shall be able to demonstrate experience in implementing energy management systems for sites, such as ISO 50001 or equivalent, as part of facilities management arrangements.</p> <p><b>Verification:</b></p> <p>The DBO contractor or property developer shall provide management system certifications for sites they operate or have operated over the last three years..</p>

*Supporting notes:*

- The evaluation of consultants, design teams and contractors requires an experienced evaluation panel. It may be appropriate to bring in external expertise, which may include appointment of a project manager, and the setting up of a panel with the knowledge and experience to judge the experience of competing contractors. The lists included in selection criterion 1 and 2 are indicative and should be adapted to the project and the procurement stage.
- In the reform of the Public Procurement Directives <sup>22 23</sup> (published in the Official Journal 28<sup>th</sup> March 2014 and requiring transposition by Member States within 24 months), it is explicitly stated (Art. 66 of Directive 2014/24/EU) that the organisation, qualification and experience of staff assigned to performing the contract (where the quality of the staff assigned can have a significant impact on the level of performance of the contract) can be a criterion for awarding a contract. For complex contracts such as building contracts it can usually be expected that the quality of the project

<sup>22</sup> Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC

<sup>23</sup> Directive 2014/25/EU of the European Parliament and of the Council of 26 February 2014 on procurement by entities operating in the water, energy, transport and postal services sectors and repealing Directive 2004/17/

managers, design team, specialist consultants and contractors can have a significant impact on the performance of the project. Please note that the educational and professional qualifications of the service provider or contractor or those of the undertaking's managerial staff may only be evaluated *once* in a tender procedure, either at selection stage or as an award criterion (Annex XII, Part 2 f of Directive 2014/24/EU).



## 2.2 Energy related criteria

The main focus of the proposed energy criteria are on the overall primary energy demand of an office building. Lighting systems are an important contributor to energy-related environmental impacts and so, if these are not addressed within the national energy calculation methodology of a Member State, lighting criteria are additionally proposed. Once an efficient building has been designed, the potential contribution of low or zero carbon energy technologies should be addressed.

For each criteria area, overall technical specifications setting performance requirements are proposed. Recognising the importance of monitoring, testing and commissioning to ensure that a building's completed performance is comparable with the expected design performance, associated technical specifications and contract performance clauses are also proposed. These would require the building fabric to be tested and for building systems to be installed and commissioned correctly.

With regards to commissioning, a single technical specification is proposed requiring functional performance testing for the following sub-systems, which in most building designs will be interlinked:

- Heating, cooling and ventilation (HVAC),
- Lighting controls,
- Building Energy Management System (BEMS),
- Low and Zero Carbon energy technologies.

In each case, tenderers would have to comply with a technical specification requiring testing and there would be a contract performance clause requiring them to report the results and, in the case of the building fabric, to propose remedies if problems are identified. Specific contract performance clauses are proposed for each sub-system.

### 2.2.1.1 Performance requirements: minimum energy performance

#### 2.2.1.1.1 Background technical discussion and rationale

The preliminary technical background reports for the office building product group indicated that primary energy use during the occupation of a building – also referred to as the use phase – is associated with the most significant environmental impacts. These impacts are mainly attributed to greenhouse gas emissions from the consumption of electricity and natural gas for heating, cooling, ventilation, lighting and hot water. The balance of heating, cooling and lighting energy use varies depending on the climate zone in which the building is located.

For the main energy performance criterion for office buildings, the potential to set Core and Comprehensive technical specifications for both new-build and major renovated offices is considered in the following sections:

#### *The setting of minimum performance requirements at Member State level*

The energy use of office buildings is regulated at Member State level by building regulations and ordinances that set minimum performance requirements for both new and renovated buildings, as required by the Energy Performance of Building Directive (EPBD) <sup>24</sup>. These are usually expressed in kWh/m<sup>2</sup> of total primary energy consumption per year or carbon dioxide emissions per m<sup>2</sup> per year <sup>25</sup>. These minimum performance requirements can in most cases be equated to Energy Performance Certificate (EPC) ratings, which under the recast EPBD (2010) must be provided for all new and existing buildings that are sold on the property market.

The recast EPBD does not impose a single calculation method or EPC format on Member States, with the supporting standard EN 15603 and its related standards (such as EN 13970) as a general reference. As a result National Calculation Methods and EPC formats vary across the EU, as evidenced by a sample of the minimum requirements from different climate zones presented in Table 2.1. In some Member States these requirements reflect different climate zones (*e.g. Romania*), the difference between air conditioned and naturally ventilated offices (*e.g. France*) as well as heating and cooling performance (*e.g. Italy*).

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<sup>24</sup> Directive 2010/31/EC of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (recast)

<sup>25</sup> Concerted Action EPD (2011) *Implementing the Energy Performance of Buildings Directive*, Intelligent Energy Europe programme

**Table 2.1 Comparison of how minimum energy performance requirements are expressed in selected Member States (as of December 2014)**

Climate zone	Member State	Building code reference	Minimum energy performance requirement	
			New-build	Renovation
<b>Northern Europe</b>	Estonia	Minimum Energy Performance Requirements Act	<ul style="list-style-type: none"> <li>- Office buildings 160 kWh/m<sup>2</sup>/yr (EPC rating D)</li> <li>- Public buildings 200 kWh/m<sup>2</sup>/yr (EPC rating E)</li> </ul>	<ul style="list-style-type: none"> <li>- Office buildings 200 kWh/m<sup>2</sup>/yr (EPC rating E)</li> <li>- Public buildings 250 kWh/m<sup>2</sup>/yr (EPC rating F)</li> </ul>
	Finland	National Building Code of 2012	E-Value (primary energy consumption) 170 kWh/m <sup>2</sup> /yr (EPC rating E)	E-Value (primary energy consumption) 136 kWh/m <sup>2</sup> /yr (EPC rating D)
	Sweden	National Building Code of 2015	Climate zone III (80% population) <ul style="list-style-type: none"> <li>- Electrically heated 50 kWh/m<sup>2</sup>/yr (EPC rating C)</li> <li>- Non-electrically heated 70 kWh/m<sup>2</sup>/yr (EPC rating C)</li> </ul>	With reference to the targets for new buildings, but <i>with regards to size and potential of the building for renovation.</i>
<b>Central Europe</b>	Hungary	Ministerial Order 2015	<i>Adjusted according to surface area : volume ratio</i> 130 – 160 kWh/m <sup>2</sup> /yr (EPC rating E/F)	<i>Adjusted according to surface area : volume ratio.</i> 199 – 256 kWh/m <sup>2</sup> /yr (EPC rating F/G)
	The Netherlands	Energy Performance Standard for Buildings (EPG) 2015	<i>Energy performance co-efficient 0.4</i> 50 – 65 kWh/m <sup>2</sup> /yr (EPC rating A+/A++)	<i>Specific thresholds not reported</i>
	Poland	Act on the Energy Performance of Buildings 2015	Energy Performance co-efficients for heating, hot water, cooling and lighting: 140 kWh/m <sup>2</sup> /yr	Energy Performance co-efficients for heating, hot water, cooling and lighting: 161 kWh/m <sup>2</sup> /yr
	Romania	Law 372/2005 on the energy performance of buildings (recast 2013)	Range based on maximum values for five climatic zones: 75 – 127 kWh/m <sup>2</sup> /yr (EPC rating A – B)	<i>Specific thresholds not reported</i>
	United Kingdom	the Energy Performance of Buildings (England and Wales) Regulations (SI 2012/3118) as amended	<ul style="list-style-type: none"> <li>- Naturally ventilated 87 kWh/m<sup>2</sup>/yr (EPC rating B)</li> <li>- Air conditioned 155 kWh/m<sup>2</sup>/yr (EPC rating C)</li> </ul>	<i>Specific thresholds not reported</i>
<b>Southern Europe</b>	France	RT 2012 (Reglementation Thermique 2012)	<ul style="list-style-type: none"> <li>- Naturally ventilated (EC1) 70 kWh/m<sup>2</sup>/yr (EPC rating C)</li> <li>- Air conditioned (EC2) 110 kWh/m<sup>2</sup>/yr (EPC rating C)</li> </ul>	<i>Specific thresholds not reported</i>
	Italy	Law 63/2013 (enacted by Law 90/2013)	<i>Aggregated thresholds not reported</i>	<i>Aggregated thresholds not reported</i>
	Spain	Regulation of Thermal Installations in Buildings (RITE)	Dependant on climate zone: 49 – 97 kWh/m <sup>2</sup> /yr (EPC rating B – D)	Dependant on climate zone: 52 – 85 kWh/m <sup>2</sup> /yr (EPC rating B – C)

Source: ADENE (2015)

From Table 2.1 It can be seen that minimum performance requirements for new-build office buildings broadly fall into three categories:

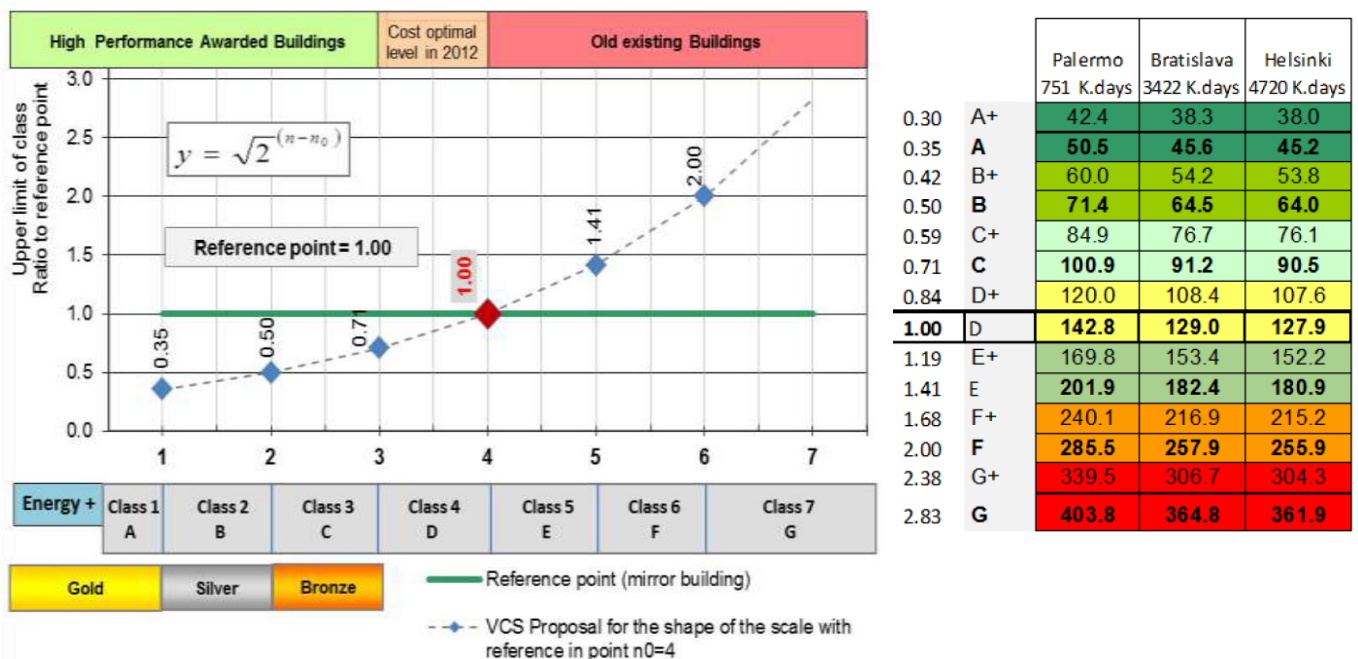
- Approaching Nearly Zero Energy Building (NZEB) performance: Those Member States where current minimum performance requirements are already approaching high performance NZEB levels (<130 kWh/m<sup>2</sup>.yr) and EPC ratings of A/B or higher. (e.g. France, Netherlands, Romania, Sweden);
- Mid-range performance: Those Member States where current minimum performance requirements are mostly in alignment with cost optimality, as reflected in EPC ratings of B/C, although in some cases they may approach high performance NZEB. (e.g. Poland, UK, Spain); or
- Low end performance: Those Member States where current minimum performance requirements may need to become stricter to bring them closer to cost optimal levels, as reflected in EPC ratings of D/E. (e.g. Estonia, Finland, Hungary)

It is likely that adjustments required to make minimum performance requirements stricter, together with the need to put in place NZEB targets for public buildings to achieve by 2018 will, taking Estonia as an example, shift low end EPC ratings into the B/C categories and, taking the example of Poland and Spain, shift mid-range EPC ratings into B or higher categories <sup>26</sup>.

#### Development of the EU Voluntary Certification Scheme

In line with the provisions of Article 11(9) of the recast EPBD, the Commission is currently developing an EU Voluntary Certification Scheme (EVCS) for non-residential buildings, to include office buildings. The proposed scheme will be founded on the new prEN 52000-1 standard, which is anticipated for publication in 2017, as its default option for the calculation and rating of energy performance of buildings. The EVCS will be supported by a European Commission Implementing Regulation which will standardise the EPC format to be used for reporting.

To support the development of the EVCS, modelling of buildings has been carried out in order to determine how best to establish EPC classes across EU climate zones. Interim findings from modelling to establish the reference points and scaling for the EPC are illustrated in Figure 2.1 <sup>27</sup>. It can be seen that the 'cost optimal' level is proposed as being aligned with EPC class D. The proposed scaling reflects the proportionately greater scope for improvement at lower classes.



**Figure 2.1: Proposed EU Voluntary Certification Scheme (EVCS) interim reference point and scale definition modelling results**

Source: ENBEE (2016)

<sup>26</sup> With reference to Member States national plans submitted to the European Commission, <https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings/nearly-zero-energy-buildings>

<sup>27</sup> Bendžalová, J., *Possible paths to the performance scale and reference for the VCS*, presentation ENBEE for the Sustainable Building Alliance consortium, 12th REHVA World Congress, Aalborg, 24.5.2016

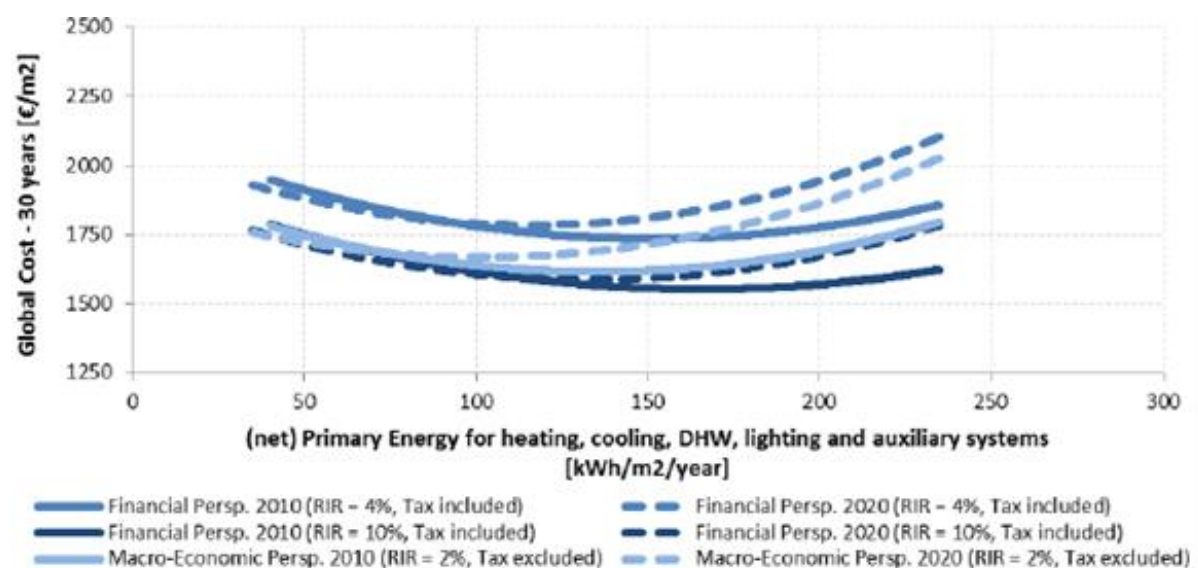
### Calibration of Member State minimum requirements with cost-optimal performance

Member States are, as already referred to, required to calibrate their minimum energy performance requirements against what is termed the 'cost-optimal' performance. The cost-optimal performance is calculated following a comparative methodology described in Commission Delegated Regulation No 244/2012<sup>28</sup>. The methodology sets out a minimum set of variables to be considered that influence a buildings energy use as well as the factors and assumptions to be included within a financial appraisal. This methodology is essentially a simplified Life Cycle Costing exercise as it cash flows the benefits of energy saving measures.

For public buildings Regulation No 244/2012 stipulates a 30-year time period for the appraisal. The discount rate is not stipulated but for public sector projects would be assumed to usually include sensitivities of 3.5%, 7% and 10%. Member States are required to then ensure that any gap between their national minimum requirements and the cost-optimal level is reduced by the time of their latest next review in 2015-6. The minimum shall in general not then be 15% greater than the cost-optimal level.

### Indicative modelling of cost-optimal levels of performance for new-build office buildings

A comprehensive modelling exercise has been carried out for DG ENER by a consortium led by Ecofys. This provides an indication of cost-optimal levels of performance for office buildings across the EU<sup>29</sup>. Geographical climate zones were defined in order to take into account of variations in primary energy requirements across the EU expressed in terms of heating and cooling days. A model was then used to simulate a reference office building to which 189 combinations of building envelope, heating and cooling strategies were applied in each climate zone. The cost-optimal performance for each variant was calculated based on an investment period of 30 years with discount rates of 2%, 4% and 10% applied. An indicative example of the modelled variation in the cost optimality curve is illustrated by Figure 2.2). The results were then segmented into notional performance classes expressed in kWh/m<sup>2</sup>. The modelled results for new-build and refurbished office buildings for the four climate zones at 2010 and (projected) 2020 prices are summarised in Table 2.2 and Table 2.3).



Source: Ecofys (2013)

**Figure 2.2: Modelled changes in cost optimality curves between 2010 and 2020 for a new office building in Paris, France**

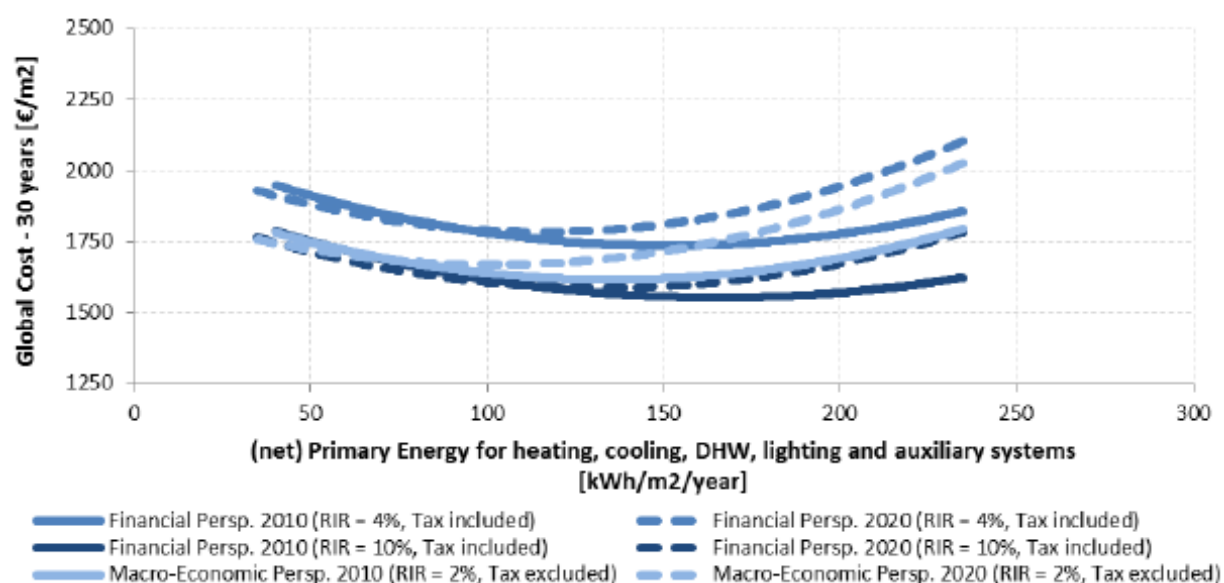
<sup>28</sup> Commission Delegated Regulation No 244/2012 of 16 January 2012 supplementing Directive 2010/31/EU of the European Parliament and of the Council on the energy performance of buildings by establishing a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements

<sup>29</sup> Ecofys Germany et al, *Towards nearly zero energy buildings: Definition of common principles under EPBD*, Report for the European Commission, 14th February 2013.

**Table 2.2: Cost-optimal new office building stock modelling results for the four EU climate zones**

Climate zone (selected city)	2010 results (kWh/m <sup>2</sup> )		2020 Cost-optimal performance (kWh/m <sup>2</sup> )
	Cost-optimal performance	Performance class for top 20% of the building variants	
Catania	120	30 - 45	80
Paris	170	30 - 45	100
Budapest	160	45 - 60	90
Stockholm	160	60 - 75	100

Source: Ecofys (2013)



Source: Ecofys (2013)

**Figure 2.3: Modelled changes in cost optimality curves between 2010 and 2020 for a new office building in Paris, France**

**Table 2.3: Cost-optimal existing office building stock modelling results for the four EU climate zones**

Climate zone (selected city)	2010 Cost-optimal performance (kWh/m <sup>2</sup> )	2020 Cost-optimal performance (kWh/m <sup>2</sup> )
Catania	120	90
Paris	170	100
Budapest	160	110
Stockholm	170	80

Source: Ecofys (2013)

In order to cross-check the findings of the Ecofys study with cost-optimal modelling in Member States a review of the current status of Member State minimum requirements and cost optimality comparisons for the four main climate zones of the EU was carried out. Data for the same countries analysed in the Ecofys study could not be compiled because of variations in the reporting by Member States. The results are summarised in Table 2.4.

The data illustrates that the variation between the current minimum national requirements and the cost-optimal can be significant. It is also notable that in most cases a 20 year term was used for the appraisal and in some cases a high discount rate, suggesting that the cost optimum performance for a public building

over 30 years and at indicative public sector borrowing rates for infrastructure (3.5%) could, depending on the combination of measures used and their cost, be lower than the figures reported.

**Table 2.4: Example outputs from cost-optimal reporting by Member States**

Country	Office building type	Current minimum requirement (kWh/m²)	Cost-optimal level (kWh/m²)	Variation from the cost-optimal level calculated	Financial assumptions (term and discount rate)
Spain	New-build	49 - 97.3	46.8 - 103.5	-6.0 to +41.4%	20 year term at 7%
	Renovation	52.1 – 85.4	42.7 – 103.0	-16.0 to +77.0%	
UK	New-build	87 - 155	89 - 163	-4%	20 year term at 3.5%
	Renovation	-	-	-	
Denmark	New-build	32.5 – 103.0	-	+31.2%	20 year term at 3.0%
	Renovation	113.2 – 231.9	-	-6.6% to +3.7%	
Finland	New-build	152 - 161	130.0 – 160.0	+3.9 to +12.6%	20 year term at 6.0%
	Renovation	136	122	+11%	
Hungary	New-build	101	84	+20.2%	20 year term at 5.0%
	Renovation	199 - 256	156 - 227	+27.6% to +12.8%	
Source: Member State reports submitted to DG ENV as of 2013, see: <a href="http://ec.europa.eu/energy/efficiency/buildings/implementation_en.htm">http://ec.europa.eu/energy/efficiency/buildings/implementation_en.htm</a>					

#### *Modelling cost-optimal levels of 'nearly zero energy' performance for office buildings*

Under the recast Energy Performance of Buildings Directive 2010/31/EU Member States are additionally required to prepare national plans to ensure that all new buildings are 'nearly zero energy' by 2020. This is defined in Article 2(2) of the Directive as:

*'...a building that has a very high energy performance, as determined in accordance with Annex I. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources,'*

Of particular relevance to GPP is an early target date for nearly zero energy public buildings of 2018. The national plan should set requirements for primary energy use expressed in kWh/m<sup>2</sup> per annum. Intermediate requirements shall be set for 2015. It is understood that fifteen Member States have already set intermediate targets, expressed either in kWh/m<sup>2</sup> or as EPC levels <sup>30</sup>. Only three Member States are understood to have set targets for major renovations.

The Ecofys consortium study for DG ENER highlights that a gap is likely to exist in practice between cost-optimal levels of performance in each Member State and nearly zero energy performance requirements, as illustrated in Figure 2.4. Experience suggests that the extent of this gap will depend on:

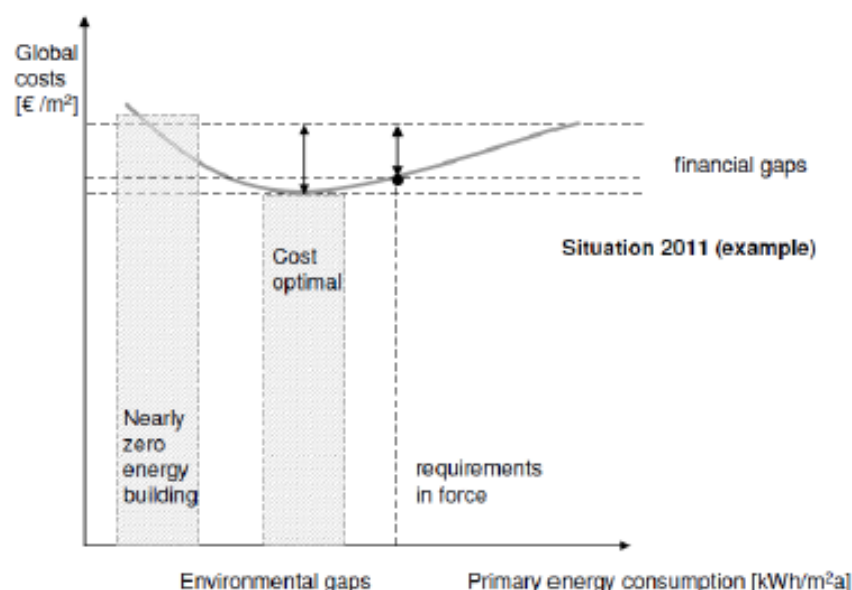
- Industry experience and skills in the cost effective delivery of new designs and specifications,
- The cost of high performance components, reflecting their availability and the maturity of the supply chain,
- Energy and carbon pricing levels for both consumers and generators of energy.

It is therefore possible that, if these factors improve, the gap would close and nearly zero energy buildings would move closer to, or even achieve, cost-optimality.

In the case of Public-Private projects the assumptions underlying Life Cycle Costing are likely to vary, with higher discount rates anticipated to be used for private sector borrowing. The open market property valuation of an office building with a higher EPC rating may also be a factor to consider, with early evidence

<sup>30</sup> COM(2013) 483 Report from the Commission to the European Parliament and the Council, Progress by Member States towards Nearly Zero-Energy Buildings, Brussels, 7.10.2013

from the property market suggesting that energy efficient buildings may receive a higher valuation or command higher rents<sup>31</sup>.



Source: Ecofys et al (2012)

**Figure 2.4: Indicative illustration of the potential gap between cost-optimal and NZE performance**

This financial gap was recognised in a study carried out by AECOM and Europe Economics for the UK Government in support of Zero Carbon targets for non-residential building to be achieved by 2019<sup>32</sup>. Modelling of office buildings to identify a cost effective approach was based on three stepwise improvements from the 2006 Building Regulations:

1. 'Advanced Energy Efficiency' measures: Those measures considered to represent the remaining cost effective measures possible to implement for an office building.
2. 'Carbon Compliance' measures: Low or zero carbon technologies that are possible to install on the building and which provide useful energy.
3. 'Allowable solutions': The balance of carbon emissions reductions from new investment in energy technologies installed off-site e.g. shared biomass heating network, wind turbines.

The study appraised the costs of selected improvement scenarios for large, medium and small offices. The aim was to explore cost effective level at which the Carbon Compliance threshold could be set relative to a 2006 baseline for the performance of an office building. These scenarios considered different mixes of efficiency measures and technologies. The Net Present Value (NPV) was calculated for each scenario. Only one scenario gave a positive Net Present Value (NPV) in the Impact Assessment<sup>33</sup>, equating to a positive outcome from an EPBD Cost-Optimality calculation. The performance thresholds that could be cost effectively achieved for each scenario are summarised in Table 2.5.

Abatement curves for the combinations of different measures show that a point of inflexion occurs past which it becomes significantly more expensive to achieve carbon emissions reductions (see the example in Figure 2.5). Hence the proposal from the UK government that further carbon reductions beyond 'carbon compliance' could then be achieved by investing in off-site infrastructure at much reduced costs in €/tonne of CO<sub>2</sub> abated – so-called 'allowable solutions'.

<sup>31</sup> European Commission, *Energy performance certificates in buildings and their impact on transaction prices and rents in selected EU countries*, Report prepared by BIO Intelligence Services and IEEP, 19th April 2013

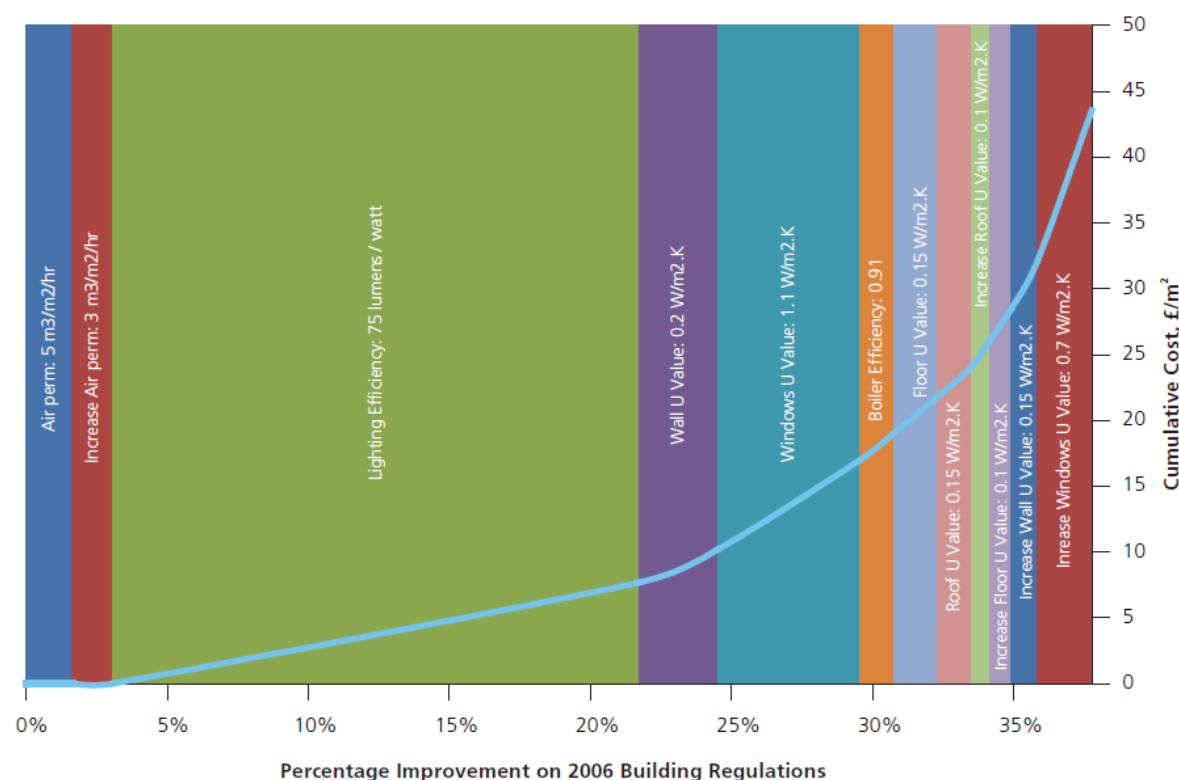
<sup>32</sup> DCLG, *Zero carbon for new non-domestic buildings: Impact assessment*, November 2009

<sup>33</sup> Net Present Value (NPV) is the value generated by an asset over a specified period of time. During this time period the cash flow generated by the asset is discounted annually by a fixed rate usually equivalent to the cost of capital. A positive NPV indicates that a project will retain its Present Value and/or deliver a return on the initial capital invested over the specified period of time.

**Table 2.5: Thresholds for energy efficiency and carbon compliance per office building type**

Building type	2006 baseline (kg CO <sub>2</sub> /m <sup>2</sup> )	Energy efficiency improvement threshold	Carbon compliance improvement threshold	
			2016	2019
Large city centre HQ	-	21%	22%	28%
Medium speculative	-	21%	23%	27-30%
Small office	18.7	38%	39%	39-53%

Source: DCLG (2009)



Source: DCLG (2009)

**Figure 2.5: Cumulative costs for achieving Energy Efficiency threshold: Small office scenario**

#### *Modelling the cost and benefit of energy efficient major renovations*

The Energy Efficiency Directive 2012/27/EU<sup>34</sup> requires that EU countries establish national plans for renovating their existing building stock. These plans shall include the 'identification of cost-effective approaches to renovations relevant to the building type and climatic zone' and 'policies and measures to stimulate cost-effective deep renovations of buildings, including staged deep renovations'. A specific renovation rate of 3% of the total floor area of central government buildings to the minimum EPBD levels is set as a target.

With the majority of the existing EU office building stock having an EPC performance in the range of D to G a major renovation generally provides the opportunity to significantly improve energy performance. The decision to retain and renovate an existing building or to demolish and/or construct a new building may need to take into account a number of factors which will need to be weighed up, including the costs and environmental benefits, which in turn will depend on the nature of the construction.

It is therefore important to first appraise whether, given the physical form and structure of the existing building, the building's environmental performance can be improved sufficiently in order to meet a contracting authority's requirements. A renovation may also provide the opportunity to make improvements

<sup>34</sup> Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency

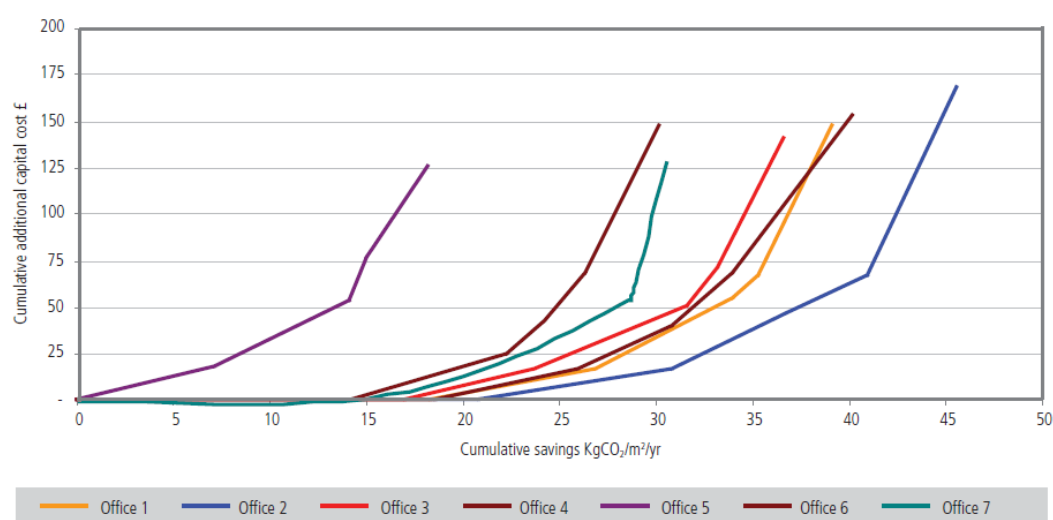


in how an asset is utilised. For example, through the improved internal use of space or the remodelling of layouts and services to better control daylighting and ventilation.

For instance, certain features of a building such as heat loss from structural elements (so-called 'thermal bridging') may preclude a cost effective level of improvement when compared to the minimum local requirements or criteria set by a contracting authority. On the other hand, given the emerging market for energy efficient building renovation, novel approaches to the renovation of common office building forms may be brought forward by designers and contractors.

Examples from the UK compiled by WRAP illustrate the improvement potential <sup>35</sup>. Hampshire County Council's Elizabeth II office complex was subjected to a major renovation in 2007-2009 <sup>36</sup>. The original building was subject to significant thermal fluctuations during the year, making for an unpleasant and expensive to operate building. An appraisal showed that for 50% of the cost of the demolition and new-build option a 50% reduction in CO<sub>2</sub> emissions could be achieved. Moreover a 70% increase in occupancy was achieved in the finished renovation, giving a reduction in CO<sub>2</sub> emissions per Council desk space.

Because of the wide range of building ages and forms that may be found across the EU it is difficult to generalise about the cost and potential for energy efficient renovation. Instead analysis has tended to focus on comparing the cost of packages of measures to reference or example office building typologies. Studies commissioned in 2009 and 2012 by the Investment Property Forum and funded by 22 major property investors illustrate the possible variation in the cost uplift to achieve reductions in primary energy consumption and improvements in EPC performance using seven and four modelled office scenarios respectively <sup>37</sup>. The analysis was carried out by the independent cost consultants Sweett. The findings are summarised in Figure 2.6 and Table 2.6.



Source: Investment Property Forum (2009)

**Figure 2.6: Additional costs to reduce primary energy consumption (7 office scenarios, 2009)**

The 2009 study concluded that making improvements in the private sector with a total additional cost increase of greater than +5% on the cost of a Category A market renovation (quoted as €840-1200/m<sup>2</sup> at 2009 prices) may be prohibitive because of sharply increasing costs and negative Internal Rates of Return (IRR's). This broadly equated to a reduction of between 42% and 51% in primary energy use. IRR's were calculated for individual improvement options to a vacant building with a discount rate of 7%.

It is notable that major improvements that would be expected to deliver the significant reductions in energy use, namely the upgrading of windows to double or triple glazing (+€127/m<sup>2</sup> and +€252/m<sup>2</sup> respectively), the addition of internal or external wall insulation (+€26m<sup>2</sup> internal and +€200 m<sup>2</sup> external) and chilled beam cooling (€168-184/m<sup>2</sup>) incur high additional costs that mean they may not recoup their costs over the lifetime of the renovation (on the basis of the respective 20 and 30 year lifespans assumed for the

<sup>35</sup> WRAP, *Refurbishment case studies: Offices*, UK <http://www.wrap.org.uk/node/12619>

<sup>36</sup> WRAP (2012) *Refurbishment Resource Efficiency Case Study: Elizabeth II Court, Winchester*

<sup>37</sup> Investment Property Forum, *Costing energy efficiency improvements in existing commercial buildings*, UK, January 2009 and July 2012

improvements analysed). They may still, however, compare favourably if a comparison is to be made with a demolition and re-build scenario, as illustrated in the previously cited UK example.

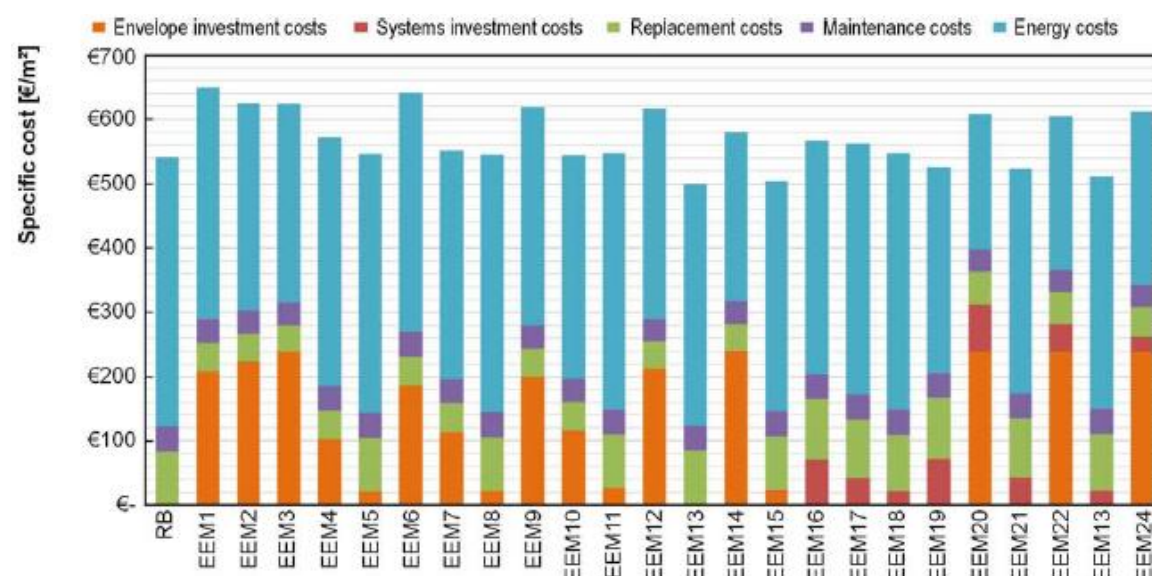
**Table 2.6: Additional costs to achieve EPC improvements (four office scenarios, 2012)**

EPC performance	Example 1: Naturally ventilated, Pre-1940	Example 2: Narrow plan, air conditioned, early 1990's	Example 3: Deep plan air conditioned, 2002	Example 4: Deep plan air conditioned, 2006
Baseline EPC	E	G	F	E
Market EPC+	D	F	F	E
<i>Additional capital costs over and above market renovation costs</i>				
E	-	0.3%	1.0%	-
D	-	1.7%	1.9%	1.0%
C	0.8%	14.6%	12.6%	12.8%
B	14.1%	37.3%	44.7%	45.7%
A	40.0%	-	-	-

Source: Investment Property Forum (2012)

These findings are broadly supported by a separate and peer reviewed modelling exercise undertaken by Torino University and Polytechnic for REHVA (the Federation of European Heating, Ventilation and Air conditioning Associations). This exercise took as its basis a methodology based on the analysis of a reference building<sup>38</sup> and the application of this methodology to an office building typology<sup>39</sup>. Twenty four packages of Energy Efficiency Measures (EEM's) were modelled and compared with a defined Reference Building (RB), with measures ranging from simple improvements to the building fabric and automatic lighting control systems to the more costly measures such as the installation of external insulation and solar photovoltaic arrays (see Figure 2.7).

The cost optimal EEM suggested a reduction of approximately 16% in primary energy consumption achieved by installing an automatic lighting control system, with a lifecycle cost reduction of 7.6%. The most significant potential reduction in primary energy consumption of 59% was achieved with improvements to the building's insulation and installation of a solar photovoltaic array on the roof. The lifecycle cost increase was estimated to be 18%. However, the modelling indicated that these measures would not pay for themselves over a reference period of 30 years at 2013 prices and at a 4% discount rate.



Source: Becchio, C et al (2013)

**Figure 2.7: Life cycle cost comparison of a Reference Building (RB) in Italy with Energy Efficiency Measures (EEM's)**

<sup>38</sup> Corgnati.S.P, Fabrizio.E, Filippi.M and V.Monetti, *Reference buildings for cost-optimal analysis: Method of definition and application*, Applied Energy, 102 (2013) p-983-993

<sup>39</sup> REHCA Task Force 'Reference buildings for energy and cost-optimal analysis' – see also Becchio.C, Corgnati.S.P, Fabrizio.E and V.Monetti, *The cost optimal methodology applied to an existing office in Italy*, REHVA Journal, October 2013.

The IPF study and REHVA analysis differ in their assumptions as to the overall costs of renovation. REHVA considered the energy improvements in isolation and the ongoing life cycle cost of running the building. The IPF study was based on the assumption that improvements form part of a 'market renovation' package equivalent to a 'Category A' fit out and that these would be made either whilst the building was occupied or upon 'vacant possession'. Although Category A has no formal definition in the EU it can be understood to include major internal improvements such as suspended ceilings and floors together with new centralised heating and cooling plant and associated services. More recent market commentary for Germany by EC Harris <sup>40</sup> suggests that for a public sector Category B renovation the typical budget might be in the range of €400-600/m<sup>2</sup> which is more in line with the assumptions used in the REHVA analysis, which suggested costs of €520/m<sup>2</sup>.

Based on an analysis of office renovations by Davis Langdon an assumption can be made that a Category A fit out would require a 30-35% increase in the budget <sup>41</sup> and would extend the economic life of a building by approximately 15-20 years. This would approximate to €532-800/m<sup>2</sup> for a public sector office building, potentially making some of the more costly improvement packages identified in both studies more difficult to justify, even if a lower discount rate of 3.5% was to be used. On the other hand energy efficiency improvements carried out as part of a major renovation may, over the life cycle of the building, be more cost effective because they make use of labour and access that is already on-site carrying out works e.g. building façade repairs require scaffolding and/or gantries.

#### *The potential for variations in the cost and lifespan of building components*

It is important to note that all of the cost and lifespan assumptions quoted in this section of the report are indicative and should be validated on a project-by-project basis as they may be subject to significant variation depending on local markets, economies of scale and the specification the building products. Alternative technical solutions may also be available that are more cost effective or enable existing building components to be upgraded (e.g. the upgrade of double glazed window units). In markets with mature renovation programmes and construction sectors the scope for cost savings may be significant.

#### *2.2.1.1.2 Summary of stakeholder feedback*

##### **Stakeholder feedback received during the final written consultation**

A stakeholder considered that in order to incentivise building renovations and NZEB buildings, a class A performance, or better, should apply to both core and comprehensive criteria, or, alternatively, the second highest class for the core criterion. Moreover, for renovations, it was considered difficult to specify a class because of the diversity of the stock. It was suggested that reference could instead be made to the life cycle cost effective savings potential. Given that EPCs are used for the criteria, it was considered important to define their scope (i.e. energy uses within a building) so as to ensure harmonisation across Member States.

It was queried as to whether it would be better to refer to non-renewable primary energy as opposed to total primary energy use. Renewable primary energy use could then be referred to separately. The reference to absolute energy consumption values was also queried because of different climatic conditions across Europe.

National calculation methodologies were felt by one stakeholder to not be suitable. Dynamic energy modelling (e.g. according to ASHRAE 90.1 or EN ISO 13790) is preferable, not just for major renovations, and would support the achievement of the thermal comfort criterion. Linked to this, it was considered that passive cooling should be promoted e.g. through the use of solar control glazing and shading systems.

One stakeholder considered reference to relevant standards for the calculation of energy performance to be useful. The standard EN 15193 was cited as an example for the *energy requirements of lighting*.

Cost optimality was not felt to be ambitious enough as a basis for the criteria as it is already applicable to all buildings that undergo major renovation. Moreover, it is considered to be difficult to implement in practice. With respect to EPC classes, a low class may be considered 'cost optimal' but will not encourage more efficient, longer term investments. Potential 'lock-in' effects were referred to.

Some of the costs quoted from references were queried and it was emphasised that sources should be independent. For example, the costs of high performance windows are heavily dependent on the type of glazing and can vary according to local market prices. Moreover, the lifespan of a window can be about 40 years as opposed to the quoted 30 years.

<sup>40</sup> EC Harris, *Office fit out costs can have an impact on profitability*, Market insight: Germany, Summer 2011

<sup>41</sup> Davis Langdon, *Cost model: Office refurbishments*, June 2012

It was considered that a link should be made with the criterion on carrying out a Life Cycle Assessment, as there may be trade-offs between higher energy performance in use and the embodied energy of producing construction materials.

*These comments are addressed in the above-given background discussion and rationale.*

### 2.2.1.1.3 Final criteria proposal

Core criteria	Comprehensive criteria
TECHNICAL SPECIFICATIONS	
<p><b>B1. Minimum Energy performance</b></p> <p><i>It is advised to have a discussion with the local building control competent authority who will be able to provide guidance on the most appropriate performance benchmark to use.</i></p> <p>The calculated energy performance of an office building shall meet the following requirements, which can be set in relation to either energy performance or cost:</p> <p>Option 1: Energy performance:</p> <ul style="list-style-type: none"> <li>For new-build projects, an Energy Performance Certificate (EPC) class C or three times the kWh/m<sup>2</sup> cut-off value <sup>42</sup> for the best class or a maximum of 135 kWh/m<sup>2</sup> (whichever is the strictest);</li> </ul> <p>For major renovations, an EPC class D or four times the kWh/m<sup>2</sup> cut-off value for the best class or a maximum of 170 kWh/m<sup>2</sup> (whichever is the strictest),</p> <p>Option 2: Cost optimal performance</p> <ul style="list-style-type: none"> <li>For new-build and major renovation projects, the cost optimum primary energy demand for a public office building expressed in kWh/m<sup>2</sup> as calculated according to the methodology in Commission Delegated Regulation No 244/2012.</li> </ul> <p>Where the national minimum requirement is stricter than these requirements, the award criterion 8.1 shall be used instead of this criterion to encourage further cost effective improved performance.</p> <p><b>Verification:</b></p> <p>The Design team or the Design &amp; Build tenderer or the DBO tenderer shall submit information demonstrating that the building design to be submitted to the local building control for permitting complies with the GPP requirements.</p> <p>This shall consist of the energy performance of the building calculated according to EN 15603 or equivalent, or the national calculation methodology applicable where the building is situated. A cost optimality calculation shall additionally be provided following the stated methodology. The calculations shall be verified by either a competent authority <sup>43</sup> or a building assessor certified to use the methodology.</p>	<p><b>B1. Minimum Energy performance</b></p> <p><i>It is advised to have a discussion with the local building control competent authority who will be able to provide guidance on the most appropriate performance benchmark to use.</i></p> <p>The calculated energy performance of an office building shall meet the following requirements:</p> <ul style="list-style-type: none"> <li>For new-build projects an Energy Performance Certificate (EPC) class B or two times the kWh/m<sup>2</sup> cut-off value <sup>42</sup> for the best class or a maximum of 100 kWh/m<sup>2</sup> (whichever is the strictest);</li> <li>For major renovations an EPC class C or three times the cut-off <sup>42</sup> for the best class or a maximum of 135 kWh/m<sup>2</sup> (whichever is the strictest).</li> </ul> <p>Where the national minimum requirement or, the national requirement for 'Nearly Zero Energy Buildings' as of 31<sup>st</sup> December 2018, is stricter than the above requirements, award criterion B8.1 shall be used instead in order to encourage further cost effective improved performance and deep renovations. Technical specification B9 shall also be used to require contributions from low and zero carbon energy technologies.</p> <p>A dynamic thermal simulation model compliant with the ISO 13790 hourly method or equivalent shall be used to validate the heating and cooling performance. For major renovations input data reflecting surveyed construction details of the building shall be used.</p> <p><b>Verification:</b></p> <p>The Design team or the Design &amp; Build tenderer or the DBO tenderer shall submit the following information demonstrating that the building design to be submitted to the local building control for permitting complies with the GPP requirements.</p> <p>This shall consist of the energy performance of the building calculated according to EN 15603 or equivalent, or the national calculation methodology applicable where the building is situated. This shall be validated by the results of modelling according to ISO 13790 or equivalent.</p> <p>The calculations shall be verified by either a competent authority <sup>44</sup> or building assessor certified to use the relevant methodologies and calculation methods.</p>

<sup>42</sup> The cut-off value represents the highest primary energy demand (expressed in kWh/m<sup>2</sup>) that is permitted within an EPC class.

<sup>43</sup> A competent authority is a national, regional or local body that is designated to implement independent control of minimum building energy performance, energy performance certificates and building inspections.

<sup>45</sup> Where the output from B1 is in kWh then this shall be converted to GWP using emissions factors for the electricity mix and the fuels used as specified in the Product Category Rules for the EPD system.

AWARD CRITERIA	
<p><b>B8.1 Minimum Energy performance requirements</b>  <i>This criterion supplements and encourages further performance improvements over and above the requirements of criterion B1.</i></p> <p>The procurer shall award points according to the modelled improvement in the energy performance of the building upon those in criterion B1. This could be based on the EPC rating or could be in gradations of improvement of 15 kWh/m<sup>2</sup>.</p> <p><b>Verification:</b>  see criterion B1.</p>	<p><b>B8.1 Minimum Energy performance requirements</b>  <i>This criterion supplements and encourages further performance improvements over and above the requirements of criterion B1.</i></p> <p>The procurer shall award points according to the modelled improvement in the energy performance of the building <i>either</i>:</p> <ul style="list-style-type: none"> <li>○ In proportion to how close the proposed design approaches the Member States national Nearly Zero Energy requirements in kWh/m<sup>2</sup> or, <i>if these are not defined</i>,</li> <li>○ On the basis of a comparison of design proposals that, depending on the prevailing national minimum requirements, have a primary energy demand: <ul style="list-style-type: none"> <li>i) Renovations: Up to 100 kWh/m<sup>2</sup></li> <li>ii) New-build: Up to 60 kWh/m<sup>2</sup></li> </ul> </li> </ul> <p>The points could be awarded in gradations of improvement of 15 kWh/m<sup>2</sup>. In all cases the combinations of measures used to achieve this performance shall result in a positive Net Present Value when the Cost-Optimal calculation methodology for a <i>public sector office building</i> is calculated according to the methodology in Commission Delegated Regulation No 244/2012.</p> <p><b>Verification:</b>  see criterion B1.</p>
<p><b>B8.2 Building life cycle GWP</b>  <i>Points shall be awarded where award criterion B10.1 for EPDs is also included in the ITT.</i></p> <p>The Global Warming Potential (GWP) <sup>45</sup> of the buildings predicted energy performance shall be calculated over the service life used in B10.1. The GWP results for B1 and B10.1 shall be added together. Points shall be awarded to the bidders with the lowest total GWP.</p> <p><b>Verification:</b>  Performance data from the verification of criterion B1 and B10.1 shall be used to calculate the GWP. The data and calculations shall be presented in a summary form.</p>	<p><b>B8.2 Building life cycle GWP</b>  <i>Points shall also be awarded where award criterion B10.1 for EPDs is also included in the ITT.</i></p> <p>The Global Warming Potential (GWP) <sup>46</sup> of the buildings predicted energy performance shall be calculated over the service life used in B10.1. The GWP results for B1 and B10.1 shall be added together. Points shall be awarded to the bidders with the lowest total GWP.</p> <p><b>Verification:</b>  Performance data from the verification of criterion B1 and B10.1 shall be used to calculate the GWP. The data and calculations shall be presented in a summary form.</p>

Summary rationale:

- The overall approach is performance focussed and technology neutral. The criteria set only a performance requirement and do not make reference to the specific design or technological solutions that could be used to meet these requirements.
- It is considered that the recast EPB Directive provides sufficient definition in Annex 1 of the minimum performance aspects to be included within national minimum requirements. A scope definition is therefore not considered to be required in the criteria and, furthermore, all bidders would need to use the same national scheme.

<sup>45</sup> Where the output from B1 is in kWh then this shall be converted to GWP using emissions factors for the electricity mix and the fuels used as specified in the Product Category Rules for the EPD system.

<sup>46</sup> See also footnote 43

- The significant variation in Member States' minimum energy performance requirements and EPC formats across the EU means that any performance-based technical specification should be flexible enough to accommodate differences, whilst still requiring performance above the regulatory minimum. The Core minimum energy performance requirement is therefore set with reference to three different reference points:
  - i. a calculated primary energy performance in kWh/m<sup>2</sup> that in a number of Member States represents an incremental improvement on minimum requirements in force in 2015/16;
  - ii. a scaling of the requirement based on the relationship between the underlying performance requirement in kWh/m<sup>2</sup> for an A rating (typically 30-50 kWh/m<sup>2</sup> per EPC grade) and a C rating (typically 90-150 kWh/m<sup>2</sup>) that in a number of Member States can be equated to an incremental improvement on the minimum requirements in force in 2015/16; *and*
  - iii. a minimum EPC rating that in a number of Member States represents an incremental improvement on minimum requirements in force in 2015/16.

The thresholds laid down also recognise that improvements beyond EPC C tend to become significantly more costly for office buildings. This is because there are diminishing returns from efficiency investments and more costly energy technology investments are required.

- In all cases, the strictest threshold of the three shall apply. Moreover, because of wide national and regional variations, discussion is advised with the local building control competent authority who will be able to provide guidance on the most appropriate performance benchmark to use.
- Technical specifications are proposed in each case for major renovations, as it is important to encourage improvements in the performance of existing buildings. Evidence suggests that, unless there are heritage restrictions on the building fabric improvements that can be made, a minimum EPC class of D is generally feasible for a modest increase in budget. An alternative option of the cost-optimal performance is also available for the Core criterion, given that in some cases alterations to a building's fabric may be prohibitive. Where there is more flexibility in how a major renovation can be carried out, performance can approach or match that of a new-build project, so a minimum EPC class C is set for the Comprehensive criterion.
- In addition, it is proposed for the Comprehensive criterion that dynamic modelling is used to validate calculations of predicted heating and cooling requirements. The standard ISO 13790 and use of the hourly method is proposed as the main reference modelling standard. For renovations, and to improve the quality of input data, it is proposed to require a building survey. The latter is intended to ensure that potential problems with the existing building stock such as thermal bridges are taken into account in the modelled performance.
- With introduction of the need for Member States to compare their minimum performance requirements for office buildings against cost-optimal levels there can be significant variations between the two values. But the cost-optimal performance may only be calculated for the private building scenario, potentially making the target less strict because discount rates will tend to be higher and repayment terms shorter.
- Calculation of the cost optimal performance according to public sector borrowing conditions is therefore proposed as an alternative to an energy performance figure or EPC rating for the Core criterion. This will in general ensure a focus on more efficient, long term investments and is considered appropriate given the need for prudent use of public money.
- For both the Core and Comprehensive criteria, if the national minimum requirements are stricter than an award criterion should also be used instead to encourage further, cost effective improvements in performance.
- Given that there appears to be a practical limit to how far an office building can progress towards a 'nearly zero energy' performance – in terms of both cost and on-site technology – an award criterion also therefore serves to invite potential contractors to bring forward advanced performance specifications on a competitive basis.
- Nearly Zero Energy can be defined in terms of Member State requirements, where these have been established at the time of publishing the ITT, or based on modelled figures for simplified EU climatic zones. Alternatively, performance thresholds can be used that have been defined based on the cost-



optimal levels projected by Ecofys et al (2013) for 2020. Past these levels, low or zero carbon energy technology is likely to be required, as they represent the limits of efficient building design.

- An additional award criterion has been added which addresses the potential trade-off between a more energy efficient building and more energy intensive construction products. This is proposed to be used if the award criterion requesting Environmental Product Declarations (EPDs) for construction products applies. This is because it is important to consider the overall Global Warming Potential (GWP) of emissions associated with the buildings construction and its use.

## 2.2.1.2 Commissioning of building energy systems

### 2.2.1.2.1 Background technical discussion and rationale

Evidence from the monitoring of building projects from design through to handover and operation suggests that the performance of the building services – i.e. the Heating, Ventilation and Cooling (HVAC) systems – is an important factor to control in the overall management of energy use. The increasing complexity of these systems means that on the one hand they can be used to intelligently control and respond to the buildings HVAC needs whilst on the other hand, if not commissioned and operated correctly, they can lead to higher energy use.

UK association CIBSE defines commissioning as *'the processes of bringing the systems into operation; their regulation; the setting up of associated control systems; plus the recording of the final settings and the state of the final system performance'*. The IEA's Energy Conservation in Buildings and Community Systems Annex 40 recognised the importance of properly function HVAC systems and developed tools to support the commissioning process<sup>47</sup>. They highlight the importance of 'Functional Performance Testing' in commissioning HVAC systems, an approach which is reflected to some extent in the EN standard 12599 for the handover of building ventilation systems. US standards organisation ASHRAE has also recently published a new commissioning standard 202 which specifically addresses the commissioning process and includes a number of areas highlighted by ECBCS Annex 40<sup>48</sup>. The importance of incorporating requirements for commissioning is, moreover, highlighted by experience from innovative projects, including those certified to existing building certification schemes<sup>49</sup>.

Evidence from surveys of buildings commissioned in the US suggests based on findings from a database of 643 buildings that energy-related commissioning problems can increase energy use by approximately 15%<sup>50</sup>. A low energy buildings programme by the Carbon Trust in the UK revealed that 40% of the building developers involved did not meet their low energy goals because of problems that could have been addressed by better commissioning. This is particularly understood to be the case where energy saving technologies such as heat pumps have been introduced. In several cases, systems have not performed according to modelled expectations – as demonstrated by findings from monitored buildings in programmes such as EnOB in Germany<sup>51</sup>.

### 2.2.1.2.2 Final criteria proposal

Core criteria	Comprehensive criteria
<b>TECHNICAL SPECIFICATIONS</b>	
<b>D2. Installation and commissioning of building energy systems</b> <i>Depending on the procurement route this may also apply to systems installed by a third party energy services contractor (see Section E).</i> The following systems shall be designed, installed and commissioned in conformance with the agreed designs and specifications: <ul style="list-style-type: none"> <li>- Heating, cooling and ventilation (HVAC)</li> </ul>	<b>D2. Installation and commissioning of building energy systems</b> <i>Depending on the procurement route this may also apply to systems installed by a third party energy services contractor (see Section E).</i> The following systems shall be designed, installed and commissioned in conformance with the agreed designs and specifications: <ul style="list-style-type: none"> <li>- Heating, cooling and ventilation (HVAC)</li> </ul>

<sup>47</sup> International Energy Agency (2004) Commissioning tools for improved energy performance, ECBCS Annex 40

<sup>48</sup> ASHRAE, *ASHRAE publish first standard focussed on the commissioning process*, 26th September 2013, <https://www.ashrae.org/news/2013/ashrae--ies-publish-first-standard-focused-on-commissioning-process>

<sup>49</sup> Turner, S.C. *Commissioning design/build projects*, ASHRAE Journal, October 2012

<sup>50</sup> Lawrence Berkeley National Laboratory, *Building Commissioning: A Golden Opportunity for Reducing Energy Costs and Greenhouse Gas Emissions*, Report prepared for the Californian Energy Commission, USA, July 21st 2009

<sup>51</sup> EnOB, *Research for energy optimised building*, Germany <http://www.enob.info/en/analysis/analysis/details/workplace-satisfaction-and-comfort/>

<ul style="list-style-type: none"> <li>- Low and Zero Carbon energy technologies</li> <li>- Building Energy Management System (BEMS)</li> <li>- Lighting controls</li> </ul> <p>Each system shall be subjected to functional performance testing, including measurement of performance.</p> <p>HVAC systems shall be in conformance with EN12599 and, as relevant to other systems installed, other applicable EN, ISO or national standards, or their equivalent.</p> <p><b>Verification:</b></p> <p>The main construction contractor or the DBO contractor shall describe and commit to carrying out a functional performance testing routine in order to ensure that the systems perform within design parameters.</p>	<ul style="list-style-type: none"> <li>- Low and Zero Carbon energy technologies</li> <li>- Building Energy Management System (BEMS)</li> <li>- Lighting controls</li> </ul> <p>Each system shall be subjected to functional performance testing, including measurement of performance.</p> <p>HVAC systems shall be in conformance with EN12599 and, as relevant to other systems installed, other applicable EN, ISO or national standards, or their equivalent.</p> <p><b>Verification:</b></p> <p>The main construction contractor or the DBO contractor shall describe and commit to carrying out a functional performance testing routine in order to ensure that the systems perform within design parameters.</p>
<b>CONTRACT PERFORMANCE CLAUSE</b>	
<p><b>D5. Installation and commissioning of building energy systems</b></p> <p><i>Depending on the procurement route, this may also apply to systems installed by a third party energy services contractor (see Section E).</i></p> <p>The following systems shall be installed and commissioned in conformance with the agreed designs and specifications:</p> <ul style="list-style-type: none"> <li>- Heating, cooling and ventilation (HVAC)</li> <li>- Low and Zero Carbon energy technologies</li> <li>- Building Energy Management System (BEMS)</li> <li>- Lighting controls</li> </ul> <p>Each system shall be subjected to functional performance testing as described in the successful tender, including measurement of performance.</p> <p>The main construction contractor or the DBO contractor shall provide a copy of the survey report or certificate confirming that testing of the building services has been carried out and providing data showing that the services perform within design parameters.</p>	<p><b>D5. Installation and commissioning of building energy systems</b></p> <p><i>Depending on the procurement route, this may also apply to systems installed by a third party energy services contractor (see Section E).</i></p> <p>The following systems shall be designed, installed and commissioned in conformance with the agreed designs and specifications:</p> <ul style="list-style-type: none"> <li>- Heating, cooling and ventilation (HVAC)</li> <li>- Low and Zero Carbon energy technologies</li> <li>- Building Energy Management System (BEMS)</li> <li>- Lighting controls</li> </ul> <p>Each system shall be subjected to functional performance testing as described in the successful tender, including measurement of performance.</p> <p>The main construction contractor or the DBO contractor shall provide a copy of the survey report or certificate confirming that testing of the building services has been carried out and providing data showing that the services perform to within design parameters.</p>

Summary rationale:

- Evidence suggests that if HVAC systems are not correctly commissioned, this can lead to increased energy consumption, particularly when low carbon energy technologies are introduced into designs.
- Commissioning routines have been developed that aim to diagnose problems before the building is used. So-called 'functional performance testing' can help in ensuring that the building's systems are more thoroughly tested before occupation, potentially avoiding additional energy use and costly interventions later on.
- A requirement is proposed for all buildings that a functional performance testing routine is carried out before occupation, with reference to EN 12599, which provides a routine for the functional checking of the installation and measuring of performance. This would be included as a contract performance clause



### 2.2.1.3 Quality of the completed building fabric

#### 2.2.1.3.1 Background technical discussion and rationale

In order to guarantee a high performing low energy building, it is important to ensure that the completed building fabric has a low level of air infiltration (i.e. it is air tight and does not leak air) and minimal thermal bridges where heat can be conducted through the buildings structure from outside to inside (or vice versa). This should be addressed at the design stage by careful detailing of the external fabric and at the construction stage by ensuring quality and precision on-site. For example, the Passivhaus standard developed in Germany and now promoted across the EU places a strong emphasis on minimising thermal bridges during design and construction, followed by post-construction testing<sup>52</sup>.

Credit is given in the BREEAM building certification criteria (see criterion ENE 6, BREEAM Commercial 2009) for careful attention to building fabric performance and the avoidance of air infiltration. Within the as-built performance measures 'comprehensive thermographic inspection' is identified in order to confirm:

- Continuity of insulation in accordance with the construction drawings,
- Avoidance of excessive thermal bridging,
- No air leakage paths through the fabric (except through intentional openings).

Recognising the need within the construction industry for improvements in detailing and, in particular, quality control on-site, Hannover City Council in Germany implemented an innovative quality control programme on phases of its demonstration EXPO 2000 urban extension. This included requirements for on-site inspections coupled with testing of the fabric integrity. The programme reported significant improvements in quality control and the level of compliance as phases of construction progressed<sup>53</sup>. The lessons learnt were then applied across the city of Hannover and may therefore be particularly relevant to public authorities or consortia procuring a series of buildings through a framework.

#### *Thermal imaging, co-heating and 'blower door' tests*

Thermal imaging using a special camera can be used to identify breaks in the integrity of a building's insulation. It can be used to assess the quality of workmanship in installing insulation and in detecting any failure in the building fabric such as ingress of moisture. The standard EN 13187 provides the basis for a qualitative evaluation of a building's fabric using thermographic imaging. In some Member States such as the UK and Ireland so-called 'accredited details' are specified which provide designers and builders with construction details that minimise thermal bridging but in general limited guidance is provided across the EU<sup>54</sup>. Only Denmark is understood to currently legally require thermal imaging to test construction quality<sup>55</sup>. In Italy there is understood to be a certification scheme for construction details.

A co-heating test is another option, which can be used to detect problems with breaks in the building envelope. In this test, the unoccupied building is sealed and maintained at a steady internal temperature for a period of 1-3 weeks in order to determine the heat loss co-efficient of the building<sup>56</sup>. This test can therefore provide data on the performance of the completed building fabric.

Problems are, however, cited with uncertainty and repeatability of co-heating tests. These relate to the period of time that the building must be held in a steady state and the related variation in possible external weather conditions, to which the test is highly sensitive<sup>57</sup>. The absence of occupants is also cited as an influencing factor, which can affect air tightness and humidity levels. Based on field trials, UK building experts are of the view that this test methodology is not presently suitable for use across the building industry as a quality assurance method. Co-heating tests are not understood to be required in any Member States.

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<sup>52</sup> Passipedia, *Thermal bridges*, Passivhaus Institut, [http://www.passipedia.org/passipedia\\_en/basics/building\\_physics\\_-\\_basics/heat\\_transfer/thermal\\_bridges#what\\_defines\\_thermal\\_bridge\\_free\\_design](http://www.passipedia.org/passipedia_en/basics/building_physics_-_basics/heat_transfer/thermal_bridges#what_defines_thermal_bridge_free_design)

<sup>53</sup> Hannover Landeshauptstadt, *Modell Kronsberg: Sustainable building for the future*, September 2000

<sup>54</sup> Asiepi (ASessment and Improvement of the EPBD Impact), *An effective Handling of Thermal Bridges in the EPBD Context*, Final Report of the IEE ASIEPI Work on Thermal Bridges, 31st March 2010

<sup>55</sup> Asiepi (ASessment and Improvement of the EPBD Impact), *Analysis of Execution Quality Related to Thermal Bridges*, 18th October 2009

<sup>56</sup> Institute for Sustainability, *Guide to Building Performance Evaluation*, <http://bpeguide.instituteforsustainability.org.uk/>

<sup>57</sup> NHBC Foundation, *Review of co-heating methodologies*, November 2013, UK

The UK PROBE series of building post-occupancy surveys during the 1990's identified uncontrolled air infiltration as a common problem in new-build completions<sup>58</sup>. The study series identified the following problems:

- Gaps in the building fabric around roof eaves, the cills and reveals of window and door frames, at junctions in the structure and between light and heavyweight cladding;
- Motorised windows and dampers intended for summer ventilation without adequate seals;
- Unnecessarily high volumes and hours of mechanical ventilation, often without heat recovery;
- Reception areas that suffered high levels of infiltration.

Whilst thermal imaging is a technique that can be used to locate breaks in the fabric insulation where there may be air infiltration a 'blower door' (fan pressurisation) test, whereby the building is sealed and pressurised, is required to quantify the level of air infiltration into a building. Best practice for air infiltration (also referred to as air leakage) is stated to be in the range of 1.5-3 m<sup>3</sup>/(h.m<sup>2</sup>) at 50 Pascals of air pressure<sup>59</sup> with lower end of the range represented by the Passivhaus standard. High performance may be more difficult and costly to achieve for major renovations so performance equating to a naturally ventilated building may be more appropriate, indicatively in the range of 5-8 m<sup>3</sup>/(h.m<sup>2</sup>) at 50 Pascals of air pressure. The EN standard 13829 provides a method for carrying out this test. It should be noted that comparability of standards is an issue because some Member States express standards as air changes and at differing air pressures<sup>60</sup>.

Recognising the importance of air tightness, at least 11 Member States now require some form of testing of the integrity of the building fabric at national or regional level, with Denmark, Ireland, France and the UK setting minimum requirements in their building regulations<sup>61</sup>. The most common form of testing is the blower door test.

#### 2.2.1.3.2 Summary of stakeholder feedback

##### Stakeholder feedback received during the final written consultation

A stakeholder proposed that a 'co-heating' test be required. The rationale given was that thermal imaging, whilst potentially identifying thermal bridges, does not provide data on the relative performance of the building fabric. It was emphasised that such a test would be carried out prior to occupation of the building.

*These comments are addressed in the above-given background discussion and rationale.*

#### 2.2.1.3.3 Final criteria proposal

Core criteria	Comprehensive criteria
<b>TECHNICAL SPECIFICATIONS</b>	
<b>F1. Quality of the completed building fabric</b> The building fabric and its construction shall be designed in order to ensure a high standard of air tightness. The design air tightness shall be 4 m <sup>3</sup> /(h.m <sup>2</sup> ) at 50 Pascals for new-build and 8 m <sup>3</sup> /(h.m <sup>2</sup> ) at 50 Pascals for major renovations. Upon completion of the building, the lead contractor shall test the quality of the finished building fabric and its construction according to EN 13829 or equivalent in order to ensure that the design performance has been achieved. <b>Verification:</b> The tenderer shall provide a commitment to carry out,	<b>F1. Quality of the completed building fabric</b> The building fabric and its construction shall be designed in order to ensure continuity of insulation and a high standard of air tightness. The design air tightness shall be 2 m <sup>3</sup> /(h.m <sup>2</sup> ) at 50 Pascals for new-build and 5 m <sup>3</sup> /(h.m <sup>2</sup> ) at 50 Pascals for major renovations. Upon completion of the building, the lead contractor shall test and evaluate the quality of the finished building fabric and its construction according to EN13187 and EN 13829 or equivalent in order to ensure that there are no defects and that the design performance has been achieved. <b>Verification:</b>

<sup>58</sup> PROBE, *Final report 4: Strategic conclusions*, Report to DEFRA (UK Government), August 1999, <http://www.usablebuildings.co.uk/Probe/ProbePDFs/SR4.pdf>

<sup>59</sup> Tight Vent Europe, *Building airtightness: A critical review of building testing, reporting and quality schemes in 10 countries*, Report No 4, September 2012.

<sup>60</sup> Energy and Thermal Improvements for Construction in Steel, *Report on National and European requirements regarding air-tightness*, 2008,

<sup>61</sup> Heike.E-K, Erhorn.H, Lahmidi.H and R.Anderson, *Airtightness requirements for high performance building Envelopes*, Published by Asiepi, 2010 and ATTMA, *Measuring air permeability of building envelopes*, Technical standard L2, October 2010

upon completion, testing of the airtightness of the building fabric and to address any defects that may arise.	The tenderer shall provide a commitment to carry out, upon completion, testing of the thermal integrity and airtightness of the building fabric and to address any defects that may arise.
<b>CONTRACT PERFORMANCE CLAUSE</b>	
<p><b>F3. Quality of the completed building fabric</b></p> <p>The lead contractor shall test the quality of the finished building fabric and its construction to ensure that they meet the design specifications for air tightness. Where defects are identified, remedies shall be proposed.</p> <p>A fan pressurisation test shall be carried out for at least 20% of the buildings useable internal floor space demonstrating that the design air tightness is 4 m<sup>3</sup>/(h.m<sup>2</sup>) at 50 Pascals for new-build and 8 m<sup>3</sup>/(h.m<sup>2</sup>) at 50 Pascals for major renovations.</p> <p>The test shall be carried out in accordance with EN 13829 or equivalent standards accepted by the respective building control body where the building is located.</p> <p>The testing shall be carried out following practical completion of the building. The contractor shall provide a copy of the survey report or certificate confirming that the building meets the air tightness requirement following a test carried out according to EN 13829 or equivalent.</p>	<p><b>F3. Quality of the completed building fabric</b></p> <p>The lead contractor shall test and evaluate the quality of the finished building fabric and its construction to ensure that they meet the design specifications for airtightness and continuity of insulation. Where defects are identified then remedies shall be proposed.</p> <p>This shall take the form of a thermal imaging evaluation carried out in accordance with EN 13187 and a fan pressurisation test for at least 20% of the buildings useable internal floor space demonstrating that the design air tightness is 2 m<sup>3</sup>/(h.m<sup>2</sup>) at 50 Pascals for new-build and 5 m<sup>3</sup>/(h.m<sup>2</sup>) at 50 Pascals for major renovations.</p> <p>The blower door test shall be carried out in accordance with EN 13829 or equivalent standards accepted by the respective building control body where the building is located.</p> <ul style="list-style-type: none"> <li>- The testing shall be carried out following practical completion of the building. The contractor shall provide a copy of the survey report or certificate confirming that: The building meets the air tightness requirement following a test carried out according to EN 13829 or equivalent.</li> <li>- There are no significant defects or irregularities in the construction details in accordance with EN 13187 or equivalent.</li> </ul>

Summary rationale:

- As the market for low energy office buildings develops, architects and construction contractors will become more experienced in the detailing of construction details at the design stage and the control of quality on-site in order to ensure that the as-built performance closely matches design performance.
- However, evidence suggests that continuity of the fabric insulation and air tightness are two areas where on-site inspection and testing have the potential to drive improvements in quality, both on the project itself and subsequent projects managed by contractors.
- An air leakage target together with a requirement for testing upon completion is proposed as a Core criterion. This will ensure a focus on air leakage from the building fabric at the design stage and during construction.
- A commitment to carry out thermal imaging upon completion is proposed as a Comprehensive criterion. This will ensure a focus on continuity of the fabric insulation at the design stage and during construction.
- Air tightness testing and thermal imaging (as appropriate) would then be carried out as a contract performance clause. The blower door test is currently a legal requirement in a number of Member States and advised in others. Thermal imaging is not currently a legal requirement in a majority of Member States but is an effective inspection tool.
- In both cases an EN standard is specified which provides a reference point for carrying out the testing and evaluation of the building fabric.
- It is not proposed to introduce a requirement for a co-heating test in order to determine a building's heat loss co-efficient, the reason being that it is not considered suitable for routine quality control, due to methodological problems. It is instead recommended to monitor performance post-occupancy.

#### 2.2.1.4 At what stage of the procurement process are the criteria relevant?

The evaluation of the minimum energy performance of an office building has been proposed as a technical specification and additionally as award criteria, to further performance improvements over and above the previous technical specifications, (both Core and Comprehensive criterion). These criteria have to be applied during the detailed design and performance requirements procurement phase. The *Design team*, the *Design & Build tenderer* or the *DBO tenderer* shall submit information demonstrating that the building design to be submitted for permitting by the local authority complies with the GPP requirements. This shall consist of the predicted energy performance of the building according to the national calculation methodology applicable where the building is situated. Either a competent authority or building assessor certified to use the methodology shall verify the calculations.

The correct installation and commissioning of building energy systems has been proposed as a technical specification (both Core and Comprehensive criterion) and is supplemented by a contract performance clause to ensure the control of the correct execution in the framework of the construction of the building or major renovation works. The main *construction contractor* or the *DBO contractor* shall, upon completion and handover, provide a copy of the survey report or certificate confirming that testing of the building services has been carried out and providing data showing that the systems perform within design parameters.

The quality of the completed building fabric has been proposed as a technical specification (both Core and Comprehensive criterion) which is supplemented by a contract performance clause to ensure the control of the correct execution in the framework of the practical completion and handover. The *contractor* shall provide a copy of the survey report or certificate confirming that there are no defects in the construction details in accordance with EN 13187 or equivalent and, where required by a criterion, EN 13829 or equivalent.

The criteria classification, their reference numbers in the criteria document and the respective procurement phase can be cross referenced as follows.

Title of the criterion	Procurement phase	Criterion classification	Criteria typology	Reference number in the criteria document
Minimum Energy performance	B. Detailed design and performance requirements	Core and Comprehensive	Technical specification	B1.
Minimum Energy performance requirements	B. Detailed design and performance requirements	Core and Comprehensive	Award criteria	B8.
Installation and commissioning of building energy systems	D. Construction of the building or major renovation works	Core and Comprehensive	Technical specification	D2.
	F. Practical completion and handover	Core and Comprehensive	Contract performance clause	D6.
Quality of the building fabric	D. Construction of the building or major renovation works	Core and Comprehensive	Technical specification	F1.
	F. Practical completion and handover	Core and Comprehensive	Contract performance clause	F3.

## 2.2.2 Lighting

### 2.2.2.1 Performance requirements: lighting control systems

#### 2.2.2.1.1 Background technical discussion and rationale

Electricity use associated with lighting is a significant contributor to the energy use of buildings. Moreover, because of the higher CO<sub>2</sub> emissions associated with electricity generation, lighting has a proportionally greater contribution to Global Warming Potential in LCA results compared to other energy uses such as heating.

Lighting is already addressed to some extent within the modelling of a buildings overall energy consumption in order to comply with national minimum requirements in each Member State. The 'common general framework for the calculation of energy performance of buildings' set out in Annex 1 of the recast Energy

Performance of Buildings Directive 2010/31/EU <sup>62</sup> requires that the methodologies used in each Member State consider built-in lighting installations and the 'positive influence' in calculations of natural lighting.

Whilst the EPBD places the main emphasis on the efficiency of the lighting technology itself, there is strong evidence to suggest that control systems are an important additional consideration <sup>63</sup> and that, as highlighted by the whole building renovation studies in Section 2.1.1.1, it can be one of the most cost effective energy saving measures. These can include occupancy sensors that turn off lights when offices or spaces are not occupied and daylight sensors that reduce artificial lighting levels in function of increased natural lighting. Post-occupancy studies of low energy buildings have also highlighted the importance of good user controls in conjunction with automatic controls to minimise use.

Whilst literature suggests that the potential savings from lighting controls can have a wide variance <sup>64</sup>, best practice indicates a potential of between 30% and 50% on lighting energy use <sup>65</sup>. Occupancy sensors appear to offer the greatest savings potential followed by daylight linked dimming, with the potential to reduce overall lighting power density to as low as 3-4 W/m<sup>2</sup> <sup>66</sup>. Indicative costs at 2011 prices are 2.7€/m<sup>2</sup> for natural lighting sensors and 7.2€/m<sup>2</sup> for occupancy sensors.<sup>67</sup>

There is a separate GPP criteria set for indoor lighting products. Whilst the main focus of the criteria is on the energy performance and lifespan of the product they also address the design of lighting systems. Technical specification 3.2.3 addresses lighting controls. The Core criterion includes requirements for time switches and/or occupancy sensors as well as automatic daylight linked dimming in common areas. The Comprehensive criterion adds a more extensive requirement for automatic daylight linked dimming in working areas.

In order to check how lighting controls are accounted for in national energy calculation methodologies, the methods used in the UK and Spain were selected. In both Member States the calculation methods include for the potential to enter detailed assumptions relating to lighting specifications. These include factors for efficiency gains from, for example, occupancy sensors and daylight linked systems.

Post occupancy surveys of low energy and passive buildings identify user control of lighting as an important factor. Controls should be both easy to use and readily available so that occupiers feel they are able to manage the comfort level in their working environment.

#### 2.2.2.1.2 Summary of stakeholder feedback

##### **Stakeholder feedback received during the final written consultation**

The need for the criteria was questioned given that lighting energy use will be reflected in Criterion B1. Moreover, it was commented that the criterion does not include a clear reference to the existing EU GPP Indoor Lighting criteria. These include reference to quality and performance standards under 3.2.1 and 3.2.2. These should be referenced so as to complement other quality aspects addressed, such as thermal comfort and air quality. It was also highlighted that there is not a clear link to the criterion addressing automatic daylight linked dimming.

*These comments are addressed in the above-given background discussion and rationale.*

#### 2.2.2.1.3 Final criteria proposal

Core criteria	Comprehensive criteria
<b>TECHNICAL SPECIFICATIONS</b>	
<b>B2. Lighting control systems</b>	<b>B2. Lighting control systems</b>
<i>Lamps and lighting design are recommended to be procured with reference to the indoor lighting EU GPP criteria.</i>	<i>Lamps and lighting design are recommended to be procured with reference to the indoor lighting EU GPP criteria.</i>

<sup>62</sup> Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (recast)

<sup>63</sup> CIBSE (2014) *Lighting control technologies and strategies to cut energy consumption*, CIBSE Journal CPD programme, <http://www.cibsejournal.com/cpd/2010-11/>

<sup>64</sup> Roisin et al, *Lighting energy savings in offices using different control systems and their real consumption*, Energy and Buildings 40 (2008) 514-523

<sup>65</sup> The Carbon Trust, *Lighting technology overview*, December 2011

<sup>66</sup> Galasiu A.D, *Energy Saving Lighting Control Systems for Open-Plan Offices: A Field Study*, LEUKOS: The Journal of the Illuminating Engineering Society of North America, Volume 4, Issue 1, 2007

<sup>67</sup> See IPF (2009)

<p>Where lighting control systems are not a minimum requirement in a Member State or their contribution is not taken into account in the national calculation method, occupancy sensors shall be installed in line with Technical Specification 3.2.3 of the indoor lighting EU GPP criteria (published in 2012).</p> <p>The indoor lighting EU GPP criteria are available here: <a href="http://ec.europa.eu/environment/gpp/pdf/Indoor%20Lighting%20-%20EU%20GPP%20Criteria%20Final%20draft.pdf">http://ec.europa.eu/environment/gpp/pdf/Indoor%20Lighting%20-%20EU%20GPP%20Criteria%20Final%20draft.pdf</a></p> <p>In addition, occupiers shall be able to control or override lighting systems in local zones or rooms within the building.</p> <p><b>Verification:</b> The Design team or the Design &amp; Build tenderer or the DBO tenderer shall provide technical specifications for the lighting control systems to be installed.</p> <p>Verification relating to commissioning and handover is addressed in Section F3.</p>	<p>Where lighting control systems are not a minimum requirement in a Member State or their contribution is not taken into account in the national calculation method, occupancy sensors and automatic daylight-linked dimming shall be installed in line with Technical Specification 3.2.3 of the indoor lighting EU GPP criteria (published in 2012).</p> <p>The indoor lighting EU GPP criteria are available here: <a href="http://ec.europa.eu/environment/gpp/pdf/Indoor%20Lighting%20-%20EU%20GPP%20Criteria%20Final%20draft.pdf">http://ec.europa.eu/environment/gpp/pdf/Indoor%20Lighting%20-%20EU%20GPP%20Criteria%20Final%20draft.pdf</a></p> <p>In addition, occupiers shall be able to control or override lighting systems in local zones or rooms within the building.</p> <p><b>Verification:</b> The Design team or the Design &amp; Build tenderer or the DBO tenderer shall provide technical specifications for the lighting control systems to be installed.</p> <p>Verification relating to commissioning and handover is addressed in Section F3.</p>
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#### Summary rationale:

- It is recommended to procure lamps and lighting design with reference to the EU GPP criteria for indoor lighting.
- Lighting control systems linked to daylighting and occupancy have a significant energy saving potential, with evidence suggesting in the range of 30% and 50%.
- The recast EPBD requires national calculation methodologies for energy to include built-in light fittings and to take into account the 'positive influence' of natural lighting. Some national calculation methodologies may include factors that can account for savings from daylight sensors linked to dimmers and occupancy sensors.
- The current GPP criteria for indoor lighting include a criterion under lighting design that addresses control systems, with a focus on occupancy and daylight sensors.
- Given that lighting controls are in part required to be accounted for within national energy calculation methodologies it is proposed that Technical specification 3.2.3 from the current GPP criteria is required only where occupancy sensors and daylight linked systems are not included.

## **2.2.2.2 Commissioning and handover of lighting control systems**

### **2.2.2.2.1 Background technical discussion and rationale**

Whilst lighting controls have been identified as an important improvement measure to save energy, such systems introduce additional complexity into the electrical installation for a building. The complex interaction between the lighting units, which may be individually controlled and networked with Digital Addressable Lighting Interfaces (DALI's), controls, sensors and the building's energy management system, require careful installation and commissioning to ensure that their use is optimised.

The IEA Task 31 project on daylighting in buildings identifies poor commissioning as the main reason for systems failing to meet design performance objectives<sup>68</sup>. For example, common issues can include the correct calibration and positioning of occupancy and daylight sensors. The current EU GPP indoor lighting design contract performance clause 3.3.1 addresses this specific issue. Moreover, Technical Specification 3.3.1 also contains a requirement for the provision of written instructions on how to manage the control systems, including the adjustment of occupancy sensors, daylighting linked controls and time switches.

<sup>68</sup> IEA, *Task 31: Daylighting buildings in the 21st Century: Calibration and commissioning guide*, 27th May 2006

### 2.2.2.2.2 Final criteria proposal

Core criteria	Comprehensive criteria
TECHNICAL SPECIFICATIONS	
<p><b>D2. Installation and commissioning of building energy systems</b></p> <p><i>Depending on the procurement route, this may also apply to systems installed by a third party energy services contractor (see Section E).</i></p> <p>The following systems shall be designed, installed and commissioned in conformance with optimised designs and specifications:</p> <ul style="list-style-type: none"> <li>- Heating, cooling and ventilation (HVAC)</li> <li>- Low and Zero Carbon energy technologies</li> <li>- Building Energy Management System (BEMS)</li> <li>- Lighting controls</li> </ul> <p>Each system shall be subjected to a functional performance testing routine, including measurement of performance.</p> <p>HVAC systems shall be in conformance with EN12599 or equivalent and, as relevant to other systems installed, other applicable EN, ISO or national standards, or their equivalent.</p> <p><b>Verification:</b></p> <p>The main construction contractor or the DBO contractor shall describe and commit to carrying out a functional performance testing routine in order to ensure that the systems perform within design parameters.</p>	<p><b>D2. Installation and commissioning of building energy systems</b></p> <p><i>Depending on the procurement route this may also apply to systems installed by a third party energy services contractor (see Section E).</i></p> <p>The following systems shall be designed, installed and commissioned in conformance with optimised designs and specifications:</p> <ul style="list-style-type: none"> <li>- Heating, cooling and ventilation (HVAC)</li> <li>- Low and Zero Carbon energy technologies</li> <li>- Building Energy Management System (BEMS)</li> <li>- Lighting controls</li> </ul> <p>Each system shall be subjected to functional performance testing routine, including measurement of performance.</p> <p>HVAC systems shall be in conformance with EN12599 or equivalent and, as relevant to other systems installed, other applicable EN, ISO or national standards, or their equivalent.</p> <p><b>Verification:</b></p> <p>The main construction contractor or the DBO contractor shall describe and commit to carrying out a functional performance testing routine in order to ensure that the systems perform within design parameters.</p>
CONTRACT PERFORMANCE CLAUSES	
<p><b>F4. Lighting control systems</b></p> <p>Systems shall be commissioned in accordance with contract performance clause 3.3.1 from the same criterion.</p> <p>The main contractor shall provide an operational manual for the systems in line with GPP indoor lighting design (technical specification) criterion 3.3.1.</p> <p>Training shall be provided to either the occupants and (<i>where relevant</i>) the appointed facilities management provider on how to use the systems. The interface with the BEMS (criterion F2) shall also be addressed.</p> <p>The Design team or the Design &amp; Build contractor or the DBO contractor shall provide a copy of the survey report or certificate confirming that testing of the lighting systems has been carried out and providing data showing that the systems perform to within design parameters. They shall additionally confirm that the required materials and training have been provided.</p>	<p><b>F4. Lighting control systems</b></p> <p>Systems shall be commissioned in accordance with contract performance clause 3.3.1 from the same criterion.</p> <p>The main contractor shall provide an operational manual for the systems in line with GPP indoor lighting design (technical specification) criterion 3.3.1.</p> <p>Training shall be provided to either the occupants and (<i>where relevant</i>) the appointed facilities management provider on how to use the systems. The interface with the BEMS (criterion F2) shall also be addressed.</p> <p>The Design team or the Design &amp; Build contractor or the DBO contractor shall provide a copy of the survey report or certificate confirming that testing of the lighting systems has been carried out and providing data showing that the systems perform to within design parameters. They shall additionally confirm that the required materials and training have been provided.</p>

#### Summary rationale:

- The correct installation and commissioning of lighting control systems, including functional testing, is an important step to ensure that the potential energy savings from the investment in technology are realised.
- It is proposed that lighting controls are commissioned using a functional testing routine and that an aftercare service with follow-up testing is encouraged as an award criterion.
- The contractor shall additionally ensure that a user manual is provided upon handover and that basic training is provided to the occupant and/or the appointed facilities manager.

#### **2.2.2.3 At what stage of the procurement process are the criteria relevant?**

The lighting control systems have been proposed as a Comprehensive technical specification to be applied during the detailed design and performance requirements procurement phase. Moreover, an operational manual and training on how to use the lighting control systems have also been proposed to be provided according to a contract performance clause to be applied during the practical completion and handover procurement phase. In detail, the *Design team* or the *Design & Build tenderer* or the *DBO tenderer* shall provide technical specifications for the lighting control systems to be installed. Moreover, during the practical completion and handover, the *Design team* or the *Design & Build contractor* or the *DBO contractor* shall demonstrate compliance with the commissioning routine and additionally provide materials and training.

The correct installation and commissioning of lighting control systems has been proposed as a contract performance clause (both for Core and Comprehensive criteria) to be applied during the Construction of the building or major renovation works procurement phase. The main *construction contractor* or the *DBO contractor* shall provide a copy of the survey report or certificate confirming that testing of the systems has been carried out and providing data showing that the systems perform to within design parameters.

The criteria classification, their reference numbers in the criteria document and the respective procurement phase can be cross referenced as follows.

Title of the criterion	Procurement phase	Criterion classification	Criteria typology	Reference number in the criteria document
Lighting control systems	B. Detailed design and performance requirements	Comprehensive	Technical specification	B2
Installation and commissioning of building energy systems	D. Construction of the building or major renovation works	Core and comprehensive	Technical specification	D2.
Lighting control systems	F. Practical completion and handover	Comprehensive	Contract performance clause	F4.

### **2.2.3 Building Energy Management System (BEMS)**

#### **2.2.3.1 Performance requirements: BEMS**

##### *2.2.3.1.1 Background technical discussion and rationale*

Building Energy Management Systems (BEMS) are increasingly installed in new and renovated office buildings, sometimes as a component of Building Management System (BMS). They allow for the digital control and co-ordination of the building services that provide heating, cooling, ventilation and lighting, as well as the resulting ambient conditions and comfort levels for occupants. IEA Task 16 on BEMS adopted the following definition<sup>69</sup>:

*'An electric control and monitoring system that has the ability to communicate data between control nodes (monitoring points) and an operator terminal. The system can have attributes for all facets of building control and management functions such as HVAC, lighting, fire, security, maintenance management and energy management.'*

Systems can integrate controls relating to timing, ambient conditions (internal and external) and occupancy. They can also provide building operators with accurate data on patterns of energy use in order to monitor

<sup>69</sup> IEA (1997) *Building Energy Management Systems: Technical synthesis reports for Annex 16 and 17*, Energy Conservation in Buildings and Community Systems programme.



and understand how energy is being consumed in the building. The use of such an active control system is specifically supported in Article 8 of the recast EPB Directive 2010/31/EU.

Experience suggests that whilst a BEMS has significant potential to facilitate energy saving, with the IEA suggesting conservative savings in the range of 15-30% based on building survey findings, the benefits tend only to be realised if the system is carefully designed and commissioned.

The critical first step for a public authority is the decision to specify that control systems are required to ensure good energy management and that a BEMS is the preferred approach. Important aspects that have been recommended to request related to the design of the BEMS include <sup>70</sup>:

- Design of a user interface that is easy to use, provides an overview of performance and allows for adjustment of important system variables;
- Engagement of building operators in the design of user interfaces;
- Specification of systems to manage energy and not just occupant comfort conditions;
- Integration of low or zero carbon technologies into the control systems so as to ensure efficient operation alongside conventional technologies.

The costs for BEMS have been estimated at 28€/m<sup>2</sup> for a major office renovation <sup>71</sup> or approximately 1.0% of a new building's total capital cost <sup>72</sup>.

#### 2.2.3.1.2 Final criteria proposal

Core criteria	Comprehensive criteria
<b>TECHNICAL SPECIFICATIONS</b>	
<p><b>B3. Building energy management system</b></p> <p>A building energy management system (BEMS) shall be installed and commissioned that provides occupants and facilities managers with real-time information on the building's energy use by using networked sensors and a minimum of half hourly utility metering.</p> <p>The user interface shall allow for information on the buildings energy use to be analysed and downloaded by occupants and facilities managers without requiring significant training.</p> <p>The performance of key aspects of the building that can be controlled by the system shall be easy to adjust i.e. lighting, heating, cooling.</p> <p><b>Verification:</b> The Design team or the Design &amp; Build tenderer or the DBO tenderer shall provide specifications for the BEMS including information about the user interface. They shall additionally demonstrate how information will be displayed, reported and made available to at least the facilities and/or energy managers for the building.</p>	<p><b>B3. Building energy management system</b></p> <p>A building energy management system (BEMS) shall be installed and commissioned that provides occupants and facilities managers with real-time information on the building's energy use by using networked sensors and a minimum of half hourly utility metering.</p> <p>The user interface shall allow for information on the buildings energy use to be analysed and downloaded by occupants and facilities managers without requiring significant training. Occupants shall also be able to adjust comfort conditions in zones of the building.</p> <p>The performance of key aspects of the building that can be controlled by the system shall be easy to adjust i.e. lighting, heating, cooling. Additionally the system shall allow for:</p> <ul style="list-style-type: none"> <li>• Analysis and control of energy uses for different zones within the building (as a minimum for heating, cooling, lighting);</li> <li>• Performance optimisation according to ambient conditions inside and outside the building, and;</li> <li>• Diagnosis of the reason for any deviations from design performance.</li> </ul> <p><b>Verification:</b> The Design team or the Design &amp; Build tenderer or the DBO tenderer shall provide specifications for the BEMS including information about the user interface. They shall additionally demonstrate how information will be displayed, reported and made available to at least the facilities and/or energy managers for the building.</p>

<sup>70</sup> The Carbon Trust, *Taking control: Lessons learned from installing control systems in low carbon buildings*, UK, August 2011

<sup>71</sup> Davis Langdon, *Cost model: Building refurbishments*, Edit of an article first appearing in Building magazine (UK), June 2012

<sup>72</sup> See IEA (2007)

### Summary rationale:

- A BEMS allows for intelligent control of building energy use by operators, with systems giving access to real-time data on the status of the energy systems and their performance. Such a system also allows for the fine-tuning of energy use on a temporal basis in response to ambient conditions, user comfort requirements, feedback from sensors and HVAC system efficiencies.
- It is important that systems incorporate any low or zero carbon energy technologies that are installed, as these usually need to work in tandem with conventional systems and it can also be difficult to commission and fine-tune their performance.
- Studies and surveys of experience with the use of BEMS suggest that they can lead to energy savings in the range of 15-30% for an estimated 1.0% additional capital cost.
- It is proposed that a basic BEMS providing real-time data on energy use is a Core technical specification and that the addition of systems for the optimisation of performance based on internal and external feedback is a Comprehensive criterion.

## **2.2.3.2 Commissioning and handover**

### **2.2.3.2.1 Background technical discussion and rationale**

Experience and guidance on the installation and use of BEMS highlights the importance of careful commissioning and handover of the systems in order to realise the potential benefits. Moreover, guidance also suggests that a badly installed system can actually result in higher than predicted energy consumption.

- As discussed in Section 2.1.3.1, functional performance testing has been identified as a critical step. Specific functional testing routines highlighted as being important include <sup>73</sup>:
- Checking that the BEMS is installed as specified;
- Checking that sensors are positioned, calibrated and function correctly;
- Checking that metering is fully functional so that the overall system outputs can be tested;
- Checking that the whole system functions once HVAC, LZC technologies and lighting installations have been completed;
- Carrying out seasonal commissioning if there is the additional budget to use the original commissioning team.

Training is also important because staff of the contracting authority or the facilities management company will need to be aware of the capabilities of the system and how they can use it to better management energy use. The system should also be documented in a user manual. This manual is important to support ongoing management of the building and to support future energy savings in case there may be changes in staff or the facilities management company.

### **2.2.3.2.2 Final criteria proposal**

Core criteria	Comprehensive criteria
<b>TECHNICAL SPECIFICATIONS</b>	
<b>D2. Installation and commissioning of building energy systems</b>  <i>Depending on the procurement route this may also apply to systems installed by a third party energy services contractor (see Section E).</i>  The following systems shall be designed, installed and commissioned in conformance with optimised designs and specifications: <ul style="list-style-type: none"><li>- Heating, cooling and ventilation (HVAC)</li><li>- Low and Zero Carbon energy technologies</li></ul>	<b>D2. Installation and commissioning of building energy systems</b>  <i>Depending on the procurement route this may also apply to systems installed by a third party energy services contractor (see Section E).</i>  The following systems shall be designed, installed and commissioned in conformance with optimised designs and specifications: <ul style="list-style-type: none"><li>- Heating, cooling and ventilation (HVAC)</li><li>- Low and Zero Carbon energy technologies</li></ul>

<sup>73</sup> The Carbon Trust, *Building controls: Realising savings through the use of controls*, CTV032 Technology overview, UK, August 2007

<ul style="list-style-type: none"> <li>- Building Energy Management System (BEMS)</li> <li>- Lighting controls</li> </ul> <p>Each system shall be subjected to functional performance testing, including measurement of performance.</p> <p>HVAC systems shall be in conformance with EN12599 or equivalent and, as relevant to other systems installed, other applicable EN, ISO or national standards, or their equivalent.</p> <p><b>Verification:</b></p> <p>The main construction contractor or the DBO contractor shall describe and commit to carrying out a functional performance testing routine in order to ensure that the systems perform within design parameters.</p>	<ul style="list-style-type: none"> <li>- Building Energy Management System (BEMS)</li> <li>- Lighting controls</li> </ul> <p>Each system shall be subjected to functional performance testing, including measurement of performance.</p> <p>HVAC systems shall be in conformance with EN12599 or equivalent and, as relevant to other systems installed, other applicable EN, ISO or national standards, or their equivalent.</p> <p><b>Verification:</b></p> <p>The main construction contractor or the DBO contractor shall describe and commit to carrying out a functional performance testing routine in order to ensure that the systems perform within design parameters.</p>
<b>CONTRACT PERFORMANCE CLAUSE</b>	
<p><b>F5. Building energy management system</b></p> <p>The BEMS shall be commissioned in accordance with the required technical specifications. The main contractor shall provide an operational manual for the Building Energy Management System (BEMS). Training shall be provided to either the occupants and (<i>where relevant</i>) the appointed facilities management provider on how to use the BEMS. This shall include use of the user interface to analyse and download energy data using accessible software tools.</p> <p>The main construction contractor or the DBO contractor shall provide:</p> <ul style="list-style-type: none"> <li>- A copy of the survey report or certificate confirming that testing of the BEMS has been carried out,</li> <li>- Data showing that the systems perform within design parameters,</li> <li>- Confirmation that the required materials and training have been provided.</li> </ul>	<p><b>F5. Building energy management system</b></p> <p>The BEMS shall be commissioned in accordance with the required technical specifications. The main contractor shall provide an operational manual for the Building Energy Management System (BEMS). Training shall be provided to the occupants and (<i>where relevant</i>) the appointed facilities management provider on how to use the BEMS. This shall include use of the user interface to analyse and download energy data using accessible software tools.</p> <p>The main construction contractor or the DBO contractor shall provide:</p> <ul style="list-style-type: none"> <li>- A copy of the survey report or certificate confirming that testing of the BEMS has been carried out,</li> <li>- Data showing that the systems perform within design parameters,</li> <li>- Confirmation that the required materials and training have been provided.</li> </ul>

Summary rationale:

- The careful commissioning of a BEMS is an important step in ensuring that it is fully functional in accordance with the design specification and as a system integrating and co-ordinating HVAC, LZC technologies and lighting systems once these have been installed and commissioned.
- The training of users of the BEMS, supported by a detailed user manual, has been shown to be important in order to ensure that benefits of such a system are realised by those who will operate it.
- It is proposed that functional performance testing, training and documentation are required as technical specifications.

### 2.2.3.3 At what stage of the procurement process are the criteria relevant?

The building energy management system has been proposed as a technical specification (both in Core and Comprehensive criteria) to be applied during the detailed design and performance requirements procurement phase. Moreover, an operational manual for the BEMS has also been proposed as technical specifications (both in Core and Comprehensive criteria) to be applied during the practical completion and handover procurement phase. The *Design team* or the *Design & Build tenderer* or the *DBO tenderer* shall provide specifications for the BEMS including information about the user interface. They shall additionally demonstrate how information will be displayed, reported and made available to at least the facilities and/or energy managers for the building. Moreover, during the practical completion and handover, the *Design team* or the *Design & Build contractor* or the *DBO contractor* shall provide materials and training.

A requirement to carry out functional performance testing as part of the commissioning of building energy systems has been proposed as a technical specification (both in Core and Comprehensive criteria) to be carried out during the construction of the building or major renovation works procurement phase. This would be monitored by a contract performance clause requiring that the main *construction contractor* or the *DBO contractor* provides a copy of the survey report or certificate confirming that testing of the building services has been carried out and providing data showing that the systems perform to within design parameters.

The criteria classification, their reference numbers in the criteria document and the respective procurement phase can be cross-referenced as follows.

<b>Title of the criterion</b>	<b>Procurement phase</b>	<b>Criterion classification</b>	<b>Criteria typology</b>	<b>Reference number in the criteria document</b>
Building energy management system	B. Detailed design and performance requirements	Core and Comprehensive	Technical specification	B3.
Installation and commissioning of building energy systems	D. Construction of the building or major renovation works	Core and Comprehensive	Technical specification	D2.
Building energy management system	F. Practical completion and handover	Core and Comprehensive	Contract performance clause	F5.

## **2.2.4 Low or zero carbon energy sources**

### **2.2.4.1 Performance requirements for energy supply systems**

#### *2.2.4.1.1 Background technical discussion and rationale*

The Renewable Energy Directive 2009/28/EC states that '*Member States shall introduce in their building regulations and codes appropriate measures in order to increase the share of all kinds of energy from renewable sources in the building sector*'<sup>74</sup>. Moreover, Member States shall also ensure that new public buildings and existing buildings subject to major renovation 'fulfill an exemplary role'.

The recast EPB Directive 2010/31/EU broadens the focus, highlighting the importance of integrating low or zero carbon energy generation systems into new building designs. In Article 6 it refers to 'high efficiency' systems that use the electricity from the grid more efficiently to provide heating or cooling (e.g. heat pumps) or which use fuels more efficiently to generate electricity, heating and cooling (e.g. Combined Heat and Power supplying district heating and cooling). It states that for new buildings:

*'...the technical, environmental and economic feasibility of high-efficiency alternative systems such as those listed below, if available, is considered and taken into account:*

*(a) decentralised energy supply systems based on energy from renewable sources;*

*(b) cogeneration;*

*(c) district or block heating or cooling, particularly where it is based entirely or partially on energy from renewable sources;*

*(d) heat pumps.'*

As already noted in Section 2.2.1, the recast EPB Directive 2010/31/EU also introduced the concept of Nearly Zero Energy Buildings (NZEB), highlighting how the remaining energy requirements should be '*covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby*'. The two extracts from the recast Directive therefore highlight the importance to office buildings of encouraging both 'high efficiency' systems and renewable energy sources. The reference to sources that are 'on-site or nearby' implies that, as highlighted by stakeholder feedback, feasibility may depend on the available resources or infrastructure in the local context.

Whilst there is no consistent reference point in EU legislation for the minimum proportion of energy that should be supplied, or the level of CO<sub>2</sub> emissions reduction to be achieved by either forms of energy

<sup>74</sup> Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources

generation, initiatives by leading public authorities across Europe have established between a 10% and 20% contribution as a de facto energy planning requirement promoted by networks such as Energie Cites and the Covenant of Mayors<sup>75</sup>. This approach was originally based on a planning ordinance established by Barcelona City Council in which the use of solar thermal or photovoltaic technology was required in new buildings<sup>76</sup>. Alternatively, in countries where district heating and cooling are more common, developers may be required to connect new buildings to existing network infrastructure<sup>77</sup>.

Evidence studies in support of Member States' building regulations on Nearly Zero Energy Buildings suggest, however, that the practical and cost effective potential for high efficiency or renewable energy systems in office buildings varies according to climate zone, building design and energy technology. The proportion of electricity that could be supplied by a roof mounted solar photovoltaic array will be constrained by the building's roof area. In contrast, a natural gas-fired Combined Heat and Power (CHP) plant could supply efficient electricity, heat and cooling to meet a whole building's needs but would still depend on fossil fuel. In the latter case such a CHP plant may already exist in the local area where the office is to be built, enabling the building to benefit from existing infrastructure. This could therefore be a cost effective solution as savings can be made on boilers and cooling plant that otherwise would have to be purchased.

The availability of third party financing to pay for energy generating technologies can help to support more ambitious targets. This is because separate financing can be sought for these technologies, secured against future sales of energy to building occupiers as well as to local electricity, heating and cooling networks. The investment is usually made by an energy service company, who are specialists in managing the costs and risks associated with energy generating equipment<sup>78</sup>.

#### 2.2.4.1.2 Summary of stakeholder feedback

##### Stakeholder feedback received during the final written consultation

The need for the criteria was questioned given that low/zero carbon energy use will be reflected in calculation methods and/or modelling for Criterion B1.

It was considered that the comprehensive target of 10% may be more or less difficult to achieve depending on the local context. It was suggested that the figure could instead be determined based on local availability, to be informed by a feasibility/opportunity study.

*These comments are addressed in the above-given background discussion and rationale.*

#### 2.2.4.1.3 Final criteria proposal

Core criteria	Comprehensive criteria
<b>TECHNICAL SPECIFICATIONS</b>	
<p><b>B4. Low or zero carbon energy sources</b></p> <p>Where the building is located so as to benefit from the potential to connect to a high efficiency and cost-effective alternative energy systems (e.g. gas cogeneration, district heating/cooling, biomass district heating), the building's energy systems shall be designed to connect to this infrastructure.</p> <p><b>Verification:</b></p> <p>The Design team or the Design &amp; Build tenderer or the DBO tenderer shall identify where existing infrastructure exists and determine whether it would be beneficial environmentally for the building to connect to this infrastructure. The primary energy savings shall be quantified.</p>	<p><b>B4. Low or zero carbon energy sources</b></p> <p>A minimum of 10% of the primary energy demand for the building shall be supplied/generated by localised renewable energy sources (e.g. solar panels, biomass boiler, wind turbines, etc) or high efficiency and cost-effective alternative systems (e.g. cogeneration, district heating/cooling, heat pumps) installed within the curtilage of the building or which are shared with other buildings.</p> <p><i>The minimum requirement could be varied depending on the local context. This could be set with reference to local planning policies and/or a scoping study for the site.</i></p> <p><b>Verification:</b></p> <p>The Design team or the Design &amp; Build tenderer or the DBO tenderer shall provide designs and drawings for the energy systems to be installed together with calculations of their modelled energy generation and the net contribution to the building's primary energy use.</p>

<sup>75</sup> POLIS co-operation project, *Solar urban planning guide*, Intelligent Energy Europe, September 2010

<sup>76</sup> C40 Cities, *Barcelona's solar hot water ordinance*, [http://www.c40.org/case\\_studies/barcelonas-solar-hot-water-ordinance](http://www.c40.org/case_studies/barcelonas-solar-hot-water-ordinance)

<sup>77</sup> Danish Board of District Heating, *Danish district heating characteristics*, <http://dbdh.dk/characteristics/>

<sup>78</sup> European Association of ESCo's (2011) *Energy Performance Contracting in the European Union*

## AWARD CRITERIA

	<p><b>B9. Low or zero carbon energy sources</b></p> <p><i>This criterion supplements and encourages improved performance over and above the requirements of criterion B4.</i></p> <p>The procurer shall award points in proportion to the additional primary energy demand for the building to be supplied/generated by localised renewable energy sources or high efficiency alternative systems installed within the curtilage of the building or which are shared with other buildings.</p> <p><b>Verification:</b> The Design team (in the case of a Design Contest) or Design &amp; Build contractor or DBO contractor shall provide designs and drawings for the energy systems to be installed together with calculations of their modelled energy generation and the net contribution to the building's primary energy use.</p>
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### Summary rationale:

- The Renewable Energy Directive 2009/28/EC highlights the exemplary role for public buildings in supporting the installation of renewable energy sources. Moreover, the recast Energy Performance of Building Directive (EPBD) 2010/31/EU highlights the importance of both high efficiency and renewable energy sources in new buildings and major renovations.
- Best practice in urban energy planning is to require a proportion (10-20%) of a new building's energy to be obtained from renewable energy sources or to require a justification why a connection should not be made to a district heating and cooling network, where they exist.
- The cost effective proportion of energy that can be obtained from low, neutral or zero CO2 emitting energy generation varies according to climate zone, building design and energy technology.
- Third party financing provided by energy service companies can be attracted on the basis of future energy contracts and can enable higher levels of on-site energy generation to be achieved, from both high efficiency and renewable energy sources.
- It is proposed that a Core requirement is made that, where available, existing heating and cooling infrastructure shall be connected to as a low cost, low risk option.
- A more ambitious Comprehensive requirement of a minimum contribution of 10% towards the primary energy use of an office building is proposed. This would be flexible, with both high efficiency and renewable energy sources promoted, and the percentage could be varied according to local planning policies and/or the findings of scoping studies for the site. Experience from a number of EU countries suggests that a minimum of 10% can be easily achieved at minimal additional cost.
- An award criterion is proposed that would incentivise proportionally greater contributions to the remaining energy requirements of an office building.

### **2.2.4.2 Commissioning and handover of energy supply systems**

#### **2.2.4.2.1 Background technical discussion and rationale**

As previously highlighted in Section 2.1.1.2, it is important that building energy technologies are thoroughly commissioned using functional performance testing routines. This is important not just to ensure that the technologies are installed and work according to design specifications, but also to ensure that they are correctly integrated with building control systems. Low and zero carbon energy generating technologies are no exception. In some cases systems can be complex, for example geothermal heat pumps, and may require careful adjustment in order to achieve design performance.

#### 2.2.4.2.2 Revised criteria proposal

Core criteria	Comprehensive criteria
<b>TECHNICAL SPECIFICATIONS</b>	
<p><b>D2. Installation and commissioning of building energy systems</b></p> <p><i>Depending on the procurement route this may also apply to systems installed by a third party energy services contractor (see Section E).</i></p> <p>The following systems shall be designed, installed and commissioned in conformance with optimised designs and specifications:</p> <ul style="list-style-type: none"> <li>- Heating, cooling and ventilation (HVAC)</li> <li>- Low and Zero Carbon energy technologies</li> <li>- Building Energy Management System (BEMS)</li> <li>- Lighting controls</li> </ul> <p>Each system shall be subjected to functional performance testing, including measurement of performance.</p> <p>HVAC systems shall be in conformance with EN 12599 or equivalent and, as relevant to other systems installed, other applicable EN, ISO or national standards, or their equivalent.</p> <p><b>Verification:</b></p> <p>The main construction contractor or the DBO contractor shall describe and commit to carrying out a functional performance testing routine in order to ensure that the systems perform within design parameters.</p>	<p><b>D2. Installation and commissioning of building energy systems</b></p> <p><i>Depending on the procurement route this may also apply to systems installed by a third party energy services contractor (see Section E).</i></p> <p>The following systems shall be designed, installed and commissioned in conformance with optimised designs and specifications:</p> <ul style="list-style-type: none"> <li>- Heating, cooling and ventilation (HVAC)</li> <li>- Low and Zero Carbon energy technologies</li> <li>- Building Energy Management System (BEMS)</li> <li>- Lighting controls</li> </ul> <p>Each system shall be subjected to functional performance testing, including measurement of performance.</p> <p>HVAC systems shall be in conformance with EN 12599 or equivalent and, as relevant to other systems installed, other applicable EN, ISO or national standards, or their equivalent.</p> <p><b>Verification:</b></p> <p>The main construction contractor or the DBO contractor shall describe and commit to carrying out a functional performance testing routine in order to ensure that the systems perform within design parameters.</p>
<b>AWARD CRITERIA</b>	
<p><b>F2. Installation and commission of low or zero carbon energy sources</b></p> <p>Additional points shall be awarded to tenderers that provide aftercare service over and above minimum warranty requirements to ensure that systems function correctly.</p> <p><b>Verification:</b></p> <p>The main construction contractor or the DBO contractor shall outline the extent of the aftercare services expressed in terms of staff time and technical scope</p>	<p><b>F2. Installation and commission of low or zero carbon energy sources</b></p> <p>Additional points shall be awarded to tenderers that provide an aftercare service over and above minimum warranty requirements to ensure that systems function correctly.</p> <p><b>Verification:</b></p> <p>The main construction contractor or the DBO contractor shall outline the extent of the aftercare services expressed in terms of staff time and technical scope.</p>
<b>CONTRACT PERFORMANCE CLAUSES</b>	
<p><b>F6. Installation and commissioning of low or zero carbon energy sources</b></p> <p>The low or zero carbon energy systems shall be commissioned in accordance with the required technical specifications.</p> <p>The main construction contractor or the DBO contractor shall provide a copy of the survey report or certificate confirming that testing of the energy systems has been carried out and providing data showing that the systems perform within design parameters.</p>	<p><b>F6. Installation and commissioning of low or zero carbon energy sources</b></p> <p>The low or zero carbon energy systems shall be commissioned in accordance with the required technical specifications.</p> <p>The main construction contractor or the DBO contractor shall provide a copy of the survey report or certificate confirming that testing of the energy systems has been carried out and providing data showing that the systems perform within design parameters.</p>



### Summary rationale:

- It is proposed that low and zero carbon energy technologies are subjected to functional performance testing alongside HVAC, BEMS and lighting controls. This will ensure that they are installed correctly and are integrated with other building systems.
- As for these other systems, it is proposed that an award criterion is used to encourage support services to adjust systems following completion and handover.

## **2.2.4.3 Heating systems including CHP**

### **2.2.4.3.1 Background technical discussion and rationale**

The most common form of energy generation installed by energy service contractors are combinations of boilers and CHP units. Both of these products are addressed by separate GPP criteria for heating systems according to defined capacity thresholds. The CHP criteria set addresses prime movers (the engine, turbine or fuel cell generating the heat and power) with an electricity generating capacity of greater than 50 kWe. The water-based heaters criteria have now been published and address boilers and heat pumps with a capacity of up to 400 kW of heat output and CHP units with an electricity generating capacity of less than or equal to 50 kWe.

Both criteria sets contain technical specifications, which specify minimum percentage requirements for primary efficiency. The CHP criteria have an additional criterion requiring that CHP units shall be demonstrated to achieve a minimum primary energy saving of at least 10% compared to separate electricity and heat production, which is an important test for office buildings because, particularly for new buildings, CHP may not always be an efficient option <sup>79</sup>.

To avoid double counting of potential energy savings by specifying a criterion that is already addressed in the overall energy calculations for a building, a brief review was made of the national calculation methodologies of UK and Spain. The aim was to check the extent to which savings in primary energy from heating systems are already addressed. In both the selected countries' methodologies, the contribution of heating systems to the energy use of the building and the emissions factor for the energy generated are calculated. The overall efficiency of the system used is therefore not accounted for.

### **2.2.4.3.2 Revised criteria proposal**

<b>Core criteria</b>	<b>Comprehensive criteria</b>
<b>TECHNICAL SPECIFICATIONS</b>	
<p><b>E1. Heating systems, including Combined Heat and Power (CHP)</b></p> <p>All heating systems, including those supplied by CHP units, that supply heat to either water or air based heating distribution systems for an office building shall meet the relevant Core GPP criteria that demonstrate the efficiency of each technology:</p> <ul style="list-style-type: none"><li>• For water-based heaters, which covers boilers and heat pumps up to 400 kW heat output and for combined heat and power units with an electricity generating capacity of less than or equal to 50 kWe: technical specifications 3.1 and 3.2 shall be met. The criteria can be accessed here: <a href="http://ec.europa.eu/environment/gpp/pdf/criteria/water_based/heaters_en.pdf">http://ec.europa.eu/environment/gpp/pdf/criteria/water_based/heaters_en.pdf</a></li><li>• For combined heat and power, which covers prime movers with an electricity generating capacity greater than 50 kWe: technical specification 3.1.1, which specifies a minimum 75% annual overall efficiency and 3.2.2, which specifies requirements for 'high efficiency' cogeneration, shall be met. The criteria can be</li></ul>	<p><b>E1. Heating systems, including Combined Heat and Power (CHP)</b></p> <p>All heating systems, including those supplied by CHP units, that supply heat to either water or air based heating distribution systems for an office building shall meet the relevant Comprehensive GPP criteria that demonstrate the efficiency of each technology:</p> <ul style="list-style-type: none"><li>• For water-based heaters, which covers boilers and heat pumps up to 400 kW heat output and for combined heat and power units with an electricity generating capacity of less than or equal to 50 kWe: technical specifications 3.1 and 3.2 shall be met. The criteria can be accessed here: <a href="http://ec.europa.eu/environment/gpp/pdf/criteria/water_based/heaters_en.pdf">http://ec.europa.eu/environment/gpp/pdf/criteria/water_based/heaters_en.pdf</a></li><li>• For combined heat and power, which covers prime movers with an electricity generating capacity of greater than 50 kWe: technical specification 3.2.1 which specifies a minimum 75% annual overall efficiency and 3.2.2 which specifies requirements for 'high efficiency' cogeneration shall be met. The criteria can be</li></ul>

<sup>79</sup> See DCLG (2009)



<p>accessed here:  <a href="http://ec.europa.eu/environment/gpp/pdf/chp_GPP_product_sheet.pdf">http://ec.europa.eu/environment/gpp/pdf/chp_GPP_product_sheet.pdf</a></p> <p><b>Verification:</b></p> <p>Tenderers shall provide technical performance data for the products proposed to be installed demonstrating how they will comply with the appropriate GPP criteria.</p>	<p>accessed here:  <a href="http://ec.europa.eu/environment/gpp/pdf/chp_GPP_product_sheet.pdf">http://ec.europa.eu/environment/gpp/pdf/chp_GPP_product_sheet.pdf</a></p> <p><b>Verification:</b></p> <p>Tenderers shall provide technical performance data for the products proposed to be installed demonstrating how they will comply with the appropriate GPP criteria.</p>
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Summary rationale:

- Where a separate contract is to be let for energy services, these criteria shall be used to communicate the required minimum technical specifications to bidders.
- It is proposed that a reference shall be made to the EU GPP criteria for water-based heating systems and CHP systems. Heating systems shall, as a minimum, comply with technical specifications 3.1 and 3.2.
- It is proposed that service engineers should carry out an evaluation of the primary energy savings achievable from CHP in order to decide whether it is the right option to procure. This is because as a standalone system it may not always be the best option for office buildings.
- CHP systems shall therefore achieve a minimum overall efficiency in line with technical specifications 3.1.1 and 3.1.2 of the EU GPP criteria for combined heat and power systems.

#### **2.2.4.4 At what stage of the procurement process are the criteria relevant?**

The low or zero carbon energy sources have been proposed as a technical specification (for both Core and Comprehensive criteria) and, additionally, as award Comprehensive criteria, to further performance improvements over and above the previous technical specifications. These criteria have to be applied during the detailed design and performance requirements procurement phase.

In the case of Core criterion, the *Design team* or the *Design & Build tenderer* or the *DBO tenderer* shall identify whether appropriate infrastructure exists and determine whether it would be beneficial environmentally for the building to connect to this infrastructure. The primary energy savings shall be quantified. In the case of Comprehensive criteria (both for technical specification and award criteria), the *Design team* or the *Design & Build tenderer* or the *DBO tenderer* shall provide designs and drawings for the energy systems to be installed together with calculations of their modelled energy generation and the net contribution to the building's primary energy use.

The installation and commissioning of building energy systems has been proposed as a technical specification (both for Core and Comprehensive criteria) to be applied during the Construction of the building or major renovation works procurement phase. Moreover, additional points shall be awarded to tenderers that provide aftercare service over and above minimum warranty requirements during the practical completion and handover procurement phase. The main *construction contractor* or the *DBO contractor* shall provide a copy of the survey report or certificate confirming that testing of the building services has been carried out and providing data showing that the systems perform within design parameters.

The choice of heating systems including Combined Heat and Power (CHP) has been proposed as a technical specification (for both Core and Comprehensive criteria) to be applied during the installation of energy systems and the supply of energy services procurement phase. *Tenderers* shall provide technical specifications for the products proposed to be installed demonstrating how they will comply with the appropriate GPP criteria

The criteria classification, their reference numbers in the criteria document and the respective procurement phase can be cross-referenced as follows.

<b>Title of the criterion</b>	<b>Procurement phase</b>	<b>Criterion classification</b>	<b>Criteria typology</b>	<b>Reference number in the criteria document</b>
Low or zero carbon energy sources	B. Detailed design and performance requirements	Core and Comprehensive	Technical specification	B4.
Low or zero carbon energy sources	B. Detailed design and performance requirements	Comprehensive	Award criterion	B9.

Installation and commissioning of building energy systems	D. Construction of the building or major renovation works	Core and Comprehensive	Technical specification	D2.
Installation and commissioning of building energy systems	F. Practical completion and handover	Core and Comprehensive	Award criterion	F2.
Heating systems including Combined Heat and Power (CHP)	E. Installation of energy systems and the supply of energy services	Core and Comprehensive	Technical specification	E1.
Installation and commissioning of low or zero carbon energy sources	F. Practical completion and handover	Core and Comprehensive	Contract performance clause	F6.

## 2.2.5 Facilities energy management

### 2.2.5.1 Reporting on energy use

#### 2.2.5.1.1 Background technical discussion and rationale

A range of data can be downloaded from a Building Energy Management System (BEMS) for analysis by building managers and occupiers. This data can be used to identify overall trends as well as to pinpoint specific energy uses within a building that could be addressed. If the facilities manager is responsible for energy use, this could form part of their contract (see section 2.2.5.2), however, if the contracting authority has their own energy manager, it can be specified that reports and data are provided to them in order to be able to take action.

#### 2.2.5.1.2 Revised criteria proposal

Core criteria	Comprehensive criteria
TECHNICAL SPECIFICATIONS	
<p><b>G1. Building energy management system</b></p> <p>The facilities manager shall produce monthly reports for the occupier using data from the Building Energy Management System (BEMS). The arrangement shall be subject to a review on an annual basis. The reports shall disaggregate heating, cooling, ventilation and lighting energy use on a seasonal basis.</p> <p><b>Verification:</b></p> <p>Potential facilities management contractors or DBO contractors shall submit their proposed format for the reports as part of their ITT response.</p>	<p><b>G1. Building energy management system</b></p> <p>The facilities manager shall produce monthly reports for the occupier using data from the Building Energy Management System (BEMS). The arrangement shall be subject to a review on an annual basis. The reports shall identify trends in energy use within the building, disaggregated so that heating, cooling and lighting can be identified on a seasonal basis as well as by zone or department. The reports shall include recommendations on remedial action and/or further energy savings that could be made.</p> <p><b>Verification:</b></p> <p>Potential facilities management contractors or DBO contractors shall submit their proposed format for the reports as part of their ITT response.</p>

#### Summary rationale:

- Feedback provided to occupiers of a building is an important step in identifying trends in energy use and potential opportunities to make savings. It can also help identifying areas where consumption is higher than expected and pinpoint where remedial action could be taken.
- It is proposed as a Core criterion that the data arising from a BEMS is taken advantage of by requiring the facilities manager, if contracted out, to provide monthly reports on a disaggregated basis to the occupier.
- This requirement could be extended in the Comprehensive criterion to include the identification of trends and the provision of recommendations on energy saving steps to the occupiers.

## 2.2.5.2 Performance-based energy contracting

### 2.2.5.2.1 Background technical discussion and rationale

The SCI Network in their guidance on how to procure innovative and sustainable construction highlights the potential in Design, Build and Operate arrangements to place contractors in charge of key operational costs<sup>80</sup>. In this way the contractor who will operate the office building, where they are responsible for ongoing energy management as part of their facilities management role, can benefit from efficiency gains because savings are internalised within their business plan instead of accruing only to the building occupier.

An example is cited by the SCI Network of a public authority in Finland that had procured school buildings on the basis of a 'shared cost' energy performance contract<sup>81</sup>. Under this arrangement any savings in energy in comparison with projections are shared between the contracting authority and the contractor<sup>82</sup>. In the cited example any increase in energy use is penalised as the contractor is made liable for these costs.

A similar arrangement may exist in so-called 'Chauffage' or 'Build-Own-Operate-Finance' (BOOT) contracts, like those provided by Berlin Energy Agency<sup>83</sup>. In this arrangement, energy savings are retained by the contractor in order to pay for energy efficient building renovations in combination with new low carbon energy supply systems.

Model contracts have been developed as part of EU funded projects such as Eurocontract<sup>84</sup>. Examples from Berlin and Austria include reference to factors and adjustments that should be taken into account when establishing contracts, including energy price fluctuations, weather events and changes in building occupancy.

A methodology such as the International Performance Measurement and Verification Protocol (IPMV)<sup>85</sup> may be used to calculate and agree the projected energy use that will form the basis for such a contractual arrangement.

### 2.2.5.2.2 Summary of feedback from the stakeholder written consultation

#### Stakeholder feedback received during the final written consultation

A stakeholder commented that the period over which the 'liability for additional costs' would arise should be longer, with at least three years proposed. This was suggested because weather conditions may vary from one year to another. Such external factors should therefore be taken into account.

*These comments are addressed in the above-given background discussion and rationale.*

### 2.2.5.2.3 Final criteria proposal

Core criteria	Comprehensive criteria
<b>TECHNICAL SPECIFICATION</b>	
<b>G2. Energy performance contract</b> The building operator or facilities manager (as appropriate) shall agree, based on the preliminary modelling of the buildings energy consumption (see criterion A1), limits on energy consumption associated with lighting, heating, cooling, ventilation and auxiliary power. This shall exclude predicted loads relating to the users such as servers and small power loads.  The contract shall be based on a minimum of ten years averaged weather and degree days data for the location. The contract shall also define adjustments to account for possible future variations in occupancy, extreme weather events and market energy costs.	<b>G2. Energy performance contract</b> The building operator or facilities manager (as appropriate) shall agree, based on the preliminary modelling of the buildings energy consumption (see criterion A1) limits on energy consumption associated with lighting, heating, cooling, ventilation and auxiliary power. This shall exclude predicted loads relating to the users such as servers and small power loads.  The contract shall be based on a minimum of ten years averaged weather and degree days data for the location. The contract shall also define adjustments to account for possible future variations in occupancy, extreme weather events and market energy costs.

<sup>80</sup> SCI Network (2012) *Procuring innovative and sustainable construction*, [www.sci-network.eu](http://www.sci-network.eu)

<sup>81</sup> The city of Jyväskylä, Finland under the Jyväskylä Optimi project to promote innovative and life cycle thinking in procurement.

<sup>82</sup> European Commission Joint Research Centre, *Energy performance contracting*, Institute for Energy and Transport, <http://iet.jrc.ec.europa.eu/energyefficiency/european-energy-service-companies/energy-performance-contracting>

<sup>83</sup> Berlin Energy Agency, *Energy Performance Contracting*, <http://www.berliner-e-agentur.de/en/topics/energy-performance-contracting>

<sup>84</sup> European Energy Service Initiative, *Eurocontract EPC toolbox*, <http://www.european-energy-service-initiative.net/eu/toolbox/eurocontract-toolbox.html>

<sup>85</sup> Efficiency Valuation Organisation, *International Performance Measurement and Verification Protocol* <http://www.evo-world.org>

<p>If energy usage were to exceed these limits, the building operator or facilities manager (as appropriate) would become liable for the additional costs. If energy usage were to be below these limits, the savings would be shared 50:50 (or an alternative agreed apportionment of the savings) with the contracting authority.</p> <p>The arrangement shall be subject to a review on an annual basis.</p> <p><b>Verification:</b> The building operator or facilities manager shall make a contractual commitment to the agreed arrangement, including the scope and energy limits. A process for independent collation and presentation of the annual data shall be provided.</p>	<p>If energy usage were to exceed these limits, the building operator or facilities manager (as appropriate) would become liable for the additional costs. If energy usage were to be below these limits, the savings would be shared 50:50 (or an alternative agreed apportionment of the savings) with the contracting authority.</p> <p>The arrangement shall be subject to a review on an annual basis.</p> <p><b>Verification:</b> The building operator or facilities manager shall make a contractual commitment to the agreed arrangement, including the scope and energy limits. A process for independent collation and presentation of the annual data shall be provided.</p>
<p><b>CONTRACT PERFORMANCE CLAUSE</b></p>	
<p><b>G4. Energy performance contract</b> Energy data shall be independently collated so that the energy performance of the building can be monitored on an annual basis against the agreed energy consumption limits. The building operator or facilities manager shall arrange for the third party collation of data from utility bills/meters and the Building Energy Management System.</p> <p>This data shall be reviewed annually by both the operator and the contracting authority in order to determine the building energy consumption and the monthly profit/loss for the operator and public authority.</p>	<p><b>G4. Energy performance contract</b> Energy data shall be independently collated so that the energy performance of the building can be monitored on an annual basis against the agreed energy consumption limits.</p> <p>The building operator or facilities manager shall arrange for the third party collation of data from utility bills/meters and the Building Energy Management System.</p> <p>This data shall be reviewed annually by both the operator and the contracting authority in order to determine the building energy consumption and the monthly profit/loss for the operator and public authority.</p>

Summary rationale:

- Energy efficient operation of buildings can be incentivised in DBO arrangements by structuring the arrangement so that the contractor benefits from any energy savings made. One example of how this can be done is through an incentive scheme whereby the contractor is penalised for greater energy use and rewarded for less energy use.
- Such an incentive framework is proposed as a combination of a technical specification and a contract performance clause, given that it can only be monitored and verified once the contract has been awarded.
- Contract conditions that take into account possible future variations in occupancy, extreme weather events and market energy costs are proposed for inclusion. This is in line with best practice and model contracts for energy services.

### 2.2.5.3 At what stage of the procurement process are the criteria relevant?

The Building energy management system has been proposed as a technical specification (both for Core and Comprehensive criteria) to be applied during the facilities management procurement phase. Potential *facilities management contractors* or *DBO contractors* shall submit their proposed format for the reports as part of their ITT response.

The Energy performance contract has been proposed as a combination of an initial technical specification complemented by a contract performance clause (both for Core and Comprehensive criteria) to be applied during the facilities management procurement phase. The *building operator* or *facilities manager* shall commit to the third party collection and verification of data from utility bills or meters and the Building Energy Management System. This shall be reviewed annually by both the operator and the contracting authority in order to determine the building energy consumption and the monthly profit/loss for the operator and public authority.

The criteria classification, their reference numbers in the criteria document and the respective procurement phase can be cross referenced as follows.

<b>Title of the criterion</b>	<b>Procurement phase</b>	<b>Criterion classification</b>	<b>Criteria typology</b>	<b>Reference number in the criteria document</b>
Building energy management system	G. Facilities management	Core and Comprehensive	Technical specification	G1.
Energy performance contract	G. Facilities management	Core and Comprehensive	Technical specification	G2.
	G. Facilities management	Core and Comprehensive	Contract Performance Clause	G4.

## 2.3 Resource efficient construction

### 2.3.1 Life cycle performance

#### 2.3.1.1 Performance requirements of the main building elements

##### 2.3.1.1.1 Background technical discussion and rationale for the final criterion proposal

As the recast EPB Directive 2010/31/EU proposes the construction of "nearly-zero-energy-buildings" by 2018 in the case of public buildings and by 2020 for other buildings, it has to be expected that in the coming years the operational impacts of buildings will decrease due to primarily heating, cooling, ventilation and lighting and the embodied impact<sup>86</sup> of the construction materials and products will become more important<sup>87</sup>. As part of the preliminary study for GPP Office Building criteria an environmental impact assessment conducted in the form of a Life Cycle Assessment (LCA, according to ISO 14040 and 14044) along the office building life cycle<sup>88</sup>, showed that, after the use phase, the construction phase gives rise to the second most significant environmental impact.

The environmental performance of a product depends generally on its use within the buildings, maintenance and repair demands on its end-of-life scenario. Interactions between construction products can cause complex impacts; therefore, the entire life cycle of the whole building has to be assessed to determine the environmental contribution of construction materials and products as well as building elements<sup>89</sup>. Materials have to be compared on the basis of a common functional unit, i.e. considering aspects such as technical performance, durability, recyclability, required maintenance, etc.

##### *Characterising the different systems used by existing building certification schemes*

Well-recognised labels that identify lower environmental impact buildings as a whole or individual construction materials and elements are those classified according to ISO 14024 as Type I Ecolabels. These generally take into account the environmental impacts along the entire life cycle. However, the most important construction materials and elements are not yet covered by these ecolabels and there is a significant variability between countries. Some ecolabels address life cycle impacts at the level of the whole building, and may include mandatory or optional criteria to carry out an LCA for the whole building.

Environmental Product Declarations (EPD), developed according to ISO 14025 and ISO 21930, are Type III labels that can provide environmental information from LCA studies in a comparable format, based on common rules, known as Product Category Rules (PCRs). EPDs do not prove that a product or material is environmentally friendlier but, generally speaking, the manufacturers make declarations in order to communicate better performance, which is usually verified by a third party. The use of EPDs could make possible a comparison of the environmental impact at the level of technically equivalent construction materials and products or at the level of building elements or even a whole building when assessing the environmental performance of a building. To be comparable, however, EPDs must have the same PCRs, to ensure that scope, methodology, data quality and environmental impact indicators are the same and that all the relevant life cycle stages have been included within the study.

With the advent of the European single market for construction products, there was a concern that national EPD schemes and building level assessment schemes would represent a barrier to trade across Europe. Therefore, two standards have been developed and published by CEN TC350:

- EN 15804<sup>90</sup>: 2012. This standard provides the PCRs for all construction products and services, with the aim to ensure that all EPDs of construction products, construction services and construction processes are derived, verified and presented in a harmonised way.
- EN 15978<sup>91</sup>: 2011. This standard deals with aggregation of the information at the building level, among other describing the rules for applying EPD in a building assessment. The identification of boundary conditions and the setting up of scenarios are major parts of the standard.

<sup>86</sup> Embodied impacts are related to the production of construction materials and products, including the resources used to manufacture products and process materials as well as emissions arising from material extraction and energy used in their processing, also termed embodied energy

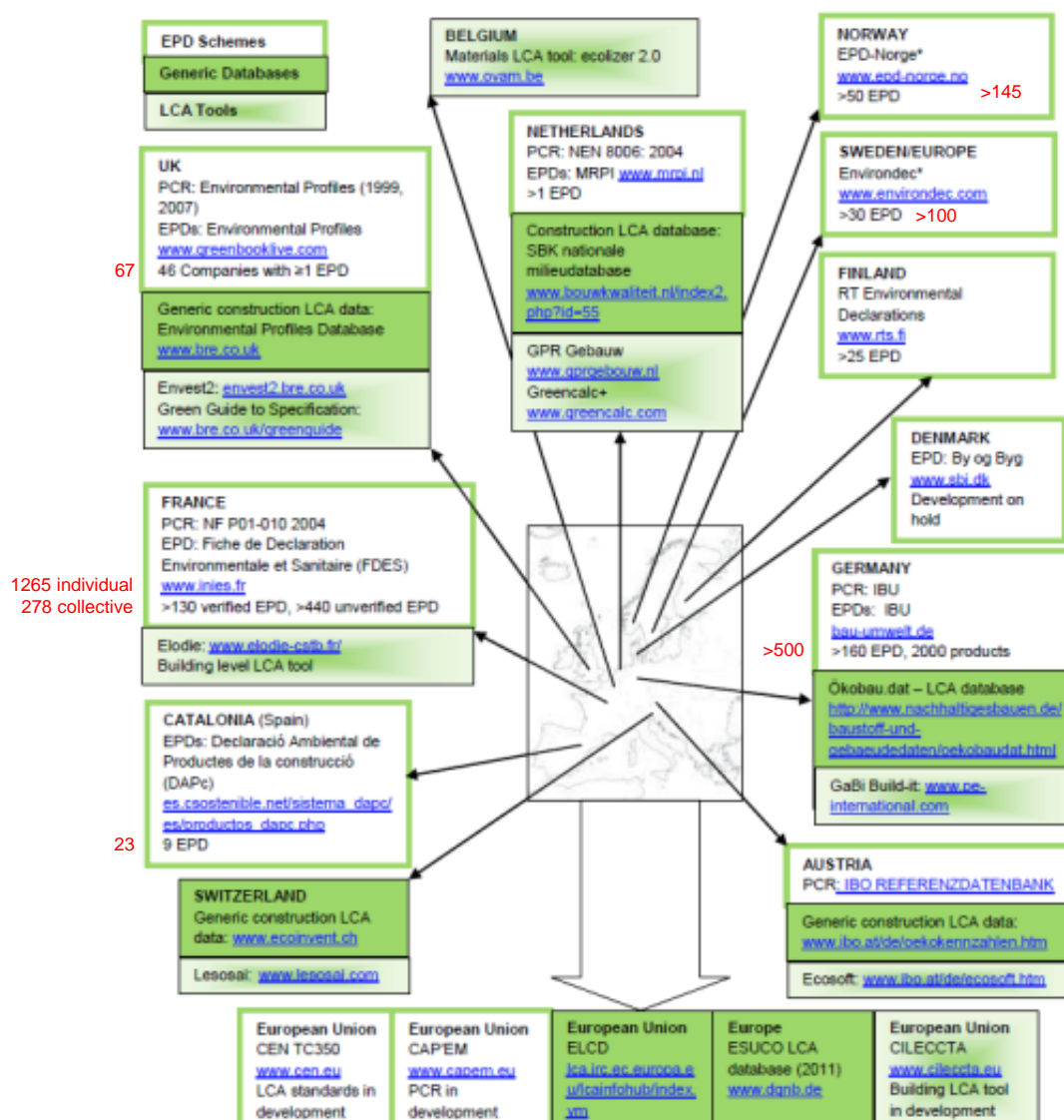
<sup>87</sup> CPA (2012) *A guide to understanding the embodied impacts of construction products*  
<http://www.constructionproducts.org.uk/sustainability/products/embodied-impacts/>

<sup>88</sup> JRC IPTS Draft Preliminary Study (2011): <http://susproc.jrc.ec.europa.eu/buildings/docs/Draft%20Report%20Task%203.pdf>

<sup>89</sup> LoRe-LCA (2011): Low Resource consumption buildings and constructions by use of LCA in design and decision making  
<http://www.sintef.com/project/LoRe-LCA/Deliverables/LoRe-LCA-WP2-D2.3-IFZ-rep%20epd-2011-12-15.pdf>

<sup>90</sup> EN 15804: 2012 + A1:2013. Sustainability of construction works - Environmental product declarations – Core rules for the product category of construction products

Many European countries, including France, Germany, the Netherlands, the Nordic countries and the UK, have developed national PCR schemes regulating the use of EPDs (see Figure 2.8). The main national EPDs schemes have been, or are in the process of being, aligned with EN 15804, such as for example the "BRE Environmental Profiles 2013: Product Category Rules (PCR) for Type III environmental product declaration of construction products to EN 15804:2012"<sup>92</sup>



EPDs numbers correct as of October 2010 – EPDs numbers updated as of July 2014 are highlighted in red

**Figure 2.8. National LCA schemes using EPDs according to the CPA guide**<sup>93</sup>

The main differences between the larger EPD schemes in terms of their scope and methodology have been highlighted in the Construction Products Association's guide to LCA and are compared in Table 2.7.

<sup>91</sup> EN 15978: 2011. Sustainability of construction works - Assessment of environmental performance of buildings - Calculation method

<sup>92</sup> BRE, *Environmental profiles*, 2013, <http://www.bre.co.uk/filelibrary/Materials/BRE-EN-15804-PCR-PN514.rev-0.1.pdf>

<sup>93</sup> CPA (2012): A guide to understanding the embodied impacts of construction products  
<http://www.constructionproducts.org.uk/sustainability/products/embodied-impacts/>

**Table 2.7. Differences between the main EPDs schemes used in Europe<sup>94</sup>**

	<b>UK</b>	<b>France</b>	<b>Germany</b>	<b>Sweden</b>
<b>Scheme</b>	BRE Environmental Profiles	Fiche de Declaration Environnementale et Sanitaire (FDES)	IBU EPD	International EPD® system (Environdec)
<b>Scope</b>	Cradle to Grave, including 60 year study period	Cradle to Grave, including study period (normally 50 years)	Cradle to Site plus optionally transport use and/or End of Life (EOL) stage	Cradle to Gate plus optionally transport use and/or End of Life (EOL) stage
<b>Declared Unit (DU) or Functional Unit (FU)</b>	FU: product in 1 m <sup>2</sup> building element over 60 year study period	DU: Product (e.g. m <sup>2</sup> /kg) over study period	DU: Product (e.g. kg/m <sup>2</sup> )	DU: Product (e.g. kg/m <sup>2</sup> )
<b>End of Life recycling</b>	Allocation from primary to recycled based on primary to scrap value	System boundary at stockpile. No allocation over system boundary	EOL modelled based on impact of disposal and any recycling, plus benefits of recycling	Waste processing / recycling included until waste has a value.
<b>Verification</b>	BRE Global verify LCA. Manufacturer data is audited and certified by BRE/BBA	From 2012, independent third party verification by verifiers certified by AFNOR required	Independent third party verification by verifiers appointed by IBU	Independent third party verification. Manufacturer can select from a list of approved verifiers

Source: Construction Products Europe (2012)

Several LCA software programs can be used to assess the environmental impact of buildings as a whole and for the selection of construction materials and products. Most of these software programs use specific databases (as Ökobau the German National construction LCIA database) or LCA databases (such as GaBi or Ecoinvent). It has to be highlighted that, nowadays, the lack of widespread and high quality available databases at European level is one of the main obstacles to be solved in order to have a harmonised and representative system.

In order to better understand the differences between different methodologies, some examples of the most used certification schemes across Europe are reported below with reference to the results presented in the EURIMA FORCE report<sup>95</sup>. It can be seen that they use a range of different approaches to the use of EPD or LCA-based construction material, product and/or element assessments,

- **BREEAM** refers to the *Green Guide to Specification* as the basis for scoring the embodied impacts of construction materials. BREEAM deals with typical building elements at a whole building level (aggregations of building products and materials e.g. wall systems), rather than separate products or materials; moreover, building foundations, parts of the core superstructure, building services and some of the fit-out are not covered. The EPD system works at a building element level and evaluates how construction materials and products contribute to the overall sustainability of the building from a cradle-to-grave perspective.

LCA data for generic and certified products for which data is submitted by industry are translated into an A+ to E rating system for building elements. In this way, solutions with low embodied impacts for any construction project can be selected. Depending on the building type, 12-15 basic credits are available in the materials category, corresponding to 11-14% of the total amount of credits available for the building (Table 2.8). Half of these credits (6-8) are based on quantified environmental information assessed according to the *BRE Methodology for Environmental Profiles of Construction Products* PCR rules. The other half of these credits are reserved for qualitative assessments regarding re-use of existing building elements, responsible sourcing and designing for robustness (e.g. adequate protection of exposed parts of the building). LCA results are thus used in BREEAM to assign a maximum of one credit (depending on if it is a new built or a renovation) to each of the following elements:

- External walls

<sup>94</sup> CPA (2012): A guide to understanding the embodied impacts of construction products  
<http://www.constructionproducts.org.uk/sustainability/products/embodied-impacts/>

<sup>95</sup> EURIMA, FORCE (2012): Analysis of five approaches to environmental assessment of building components in a whole building context  
[http://www.eurima.org/uploads/ModuleXtender/Publications/97/Force\\_Study\\_Building\\_certification\\_systems\\_May\\_2012.pdf](http://www.eurima.org/uploads/ModuleXtender/Publications/97/Force_Study_Building_certification_systems_May_2012.pdf)



- Windows
- Roof
- Upper floor slabs
- Internal walls
- Floor finishes/coverings
- Hard landscaping and boundary protection
- Insulation

The *Environmental Profiles of Construction Products* are developed according to ISO 14040. In detail, Life Cycle Inventory (LCI) is calculated using a cradle to grave approach and in/outputs of the inventory are classified and characterised with respect to 13 impact categories, summarised in Table 2.8. *Normalisation* by dividing the impacts by the annual environmental impacts caused by one UK citizen followed by a *weighting system* are applied. The normalised results in the single impact categories are multiplied with the weight assigned to that specific category and create the *Ecopoint* score.

In the final step, the rating in the *Green Guide to Specification* is calculated: the range of impacts is divided into six categories, “A+” to “E”, from lowest to highest. Ratings are given to performance in each environmental impact category and in an overall category. The rating system is only described very briefly in publicly available documents.

- **GPR Building** (NL) is an LCA tool now widely used by Dutch municipalities and professionals. It applies the Dutch harmonised LCA approach for material impacts; it is in compliance with the Dutch Energy Performance standards and it uses a multi-criteria analysis with a rating method based on realistic case studies. GPR Building is a design tool, focused not only on environmental aspects but also on the building quality. This tool can be used for both the design of new and the retrofit of existing buildings, and it is suitable for residential, office and school buildings. A building is rated on five indicators on a scale of 1 (worst) to 10 (best).

The key performance indicators are: energy, environment, health, user quality, and long term value, divided into several sub-indicators as reported in Table 2.8. 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.

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. The sub-modulus materials are based on an LCA in terms of an Eco-profile; it is composed of nine separate environmental impact indicators, as reported in Table 2.8. The nine indicators are subsequently aggregated into one index, called the “environmental shadow costs” of a building, which is expressed in euros per square meter of usable floor area (heated and unheated) per year. Harmonization of the three major calculation tools used in the Netherlands for environmental impacts assessment of buildings (GPR Buildings, GreenCalc+ and BREEAM-NL) is currently ongoing.

- **DGNB** (or German Sustainable Building Certificate) provides Gold, Silver or Bronze awards for buildings reflecting environmental, economic and social characteristics (summarised in Table 2.8). The environmental impact of the building is weighted at 22.5% of the overall score, the same as the social and economic impact and technical quality. The certification system uses a building level LCA, including the operation of the building over 50 years, to evaluate both building materials (structure, fabric, building services and fit-out) and operational energy use. The scheme therefore considers the trade-offs between embodied and operational impacts, in line with the EN 15804 and EN 15978 standards.

Each of the 11 impact assessment categories can receive a maximum of 10 points based on its documented or calculated quality. At the same time, it is possible to increase the weighting of each criterion. In the example of the scoring reported in Table 2.9, weighting factors between 1 and 3 were assigned to the different criteria. The weighting procedure is transparent, but it can still be criticised from a strict LCA point of view as expressed in ISO 14040. A performance index is calculated for each criteria group, relative to a reference building. The five performance indices are

subsequently weighted by 22.5% or 10% and the total performance index, measured in %, is calculated. Finally, the calculated total performance index is compared to pre-set values for the award of a Bronze, Silver or Gold certificate.

- **HQE** (or Haute Qualité Environnementale) is a French certification scheme. Specific targets for environmental quality within the 14 assessment categories reported in Table 2.8 have to be met in order to obtain an HQE certificate. For each category, there are three target levels, “basic”, “performing” and high performing”. In order to obtain the certificate, the building must be rated “high performing” in at least 3 categories and “basic” in maximum seven categories. Quantitative life cycle impacts of construction materials and products are assessed in category n.2 *Integrated choices in construction products, systems, and processes*, sub-categories 2.3.1 “*knowledge of environmental impacts of construction products*” and 2.3.2 “*choice of construction products to minimize environmental impacts of buildings*”. In several other categories, impacts of construction materials and products are also qualitatively assessed.
  - In subcategory n. 2.3.1, an EPD (in accordance to the French standard NF P01010 or to the equivalent European standards EN 15804 and EN 15978) must be made available
    - for at least 50% of the components in at least 2 categories of finishing products and 1 category of structural products (basic rating)
    - for at least 50% of the components in at least 4 categories of finishing products and 2 categories of structural products (performing rating)
    - for at least 80% of the components in at least 4 categories of finishing products and 2 categories of structural products (high performing rating)

A large EPD database is available, conforming to the requirements in NF P01010 and to EN 15804 ([www.inies.fr](http://www.inies.fr)).

Fulfilling this requirement also results in so called “High performing points (HP points)”:

- 2 HP points: where an EPD is made available for at least 80% of the components in all categories of products (structural and finishing)
- 3 HP points: where an EPD is made available for at least 100% of the components in all categories of products (structural and finishing).
- In subcategory n. 2.3.2, to be rated “performing”, different scenarios for the contribution of products to the overall environmental impacts must be established for either the underlying structure or for the finishing.

The HP points obtained in subcategories 2.3.1 and 2.3.2 are added to the HP points obtained in the other subcategories in category 2, and at least 35% of all points available (13 HP points out of 37) must be scored in order for category 2 to be rated “high performing”.

**Table 2.8. Comparison of main assessment methods**

<b>Scheme</b>	<b>BREEAM</b>	<b>DGNB</b>	<b>GPR</b>	<b>HQE</b>
<b>Method</b>	BRE Environmental Profiles	DGNB Certificate	GPR Building	Démarche HQE
<b>Assessment categories (score)</b>	<ol style="list-style-type: none"> <li>1. Management (12)</li> <li>2. Health &amp; Wellbeing (21)</li> <li>3. Energy (39.9)</li> <li>4. Transport (4)</li> <li>5. Water (3.6)</li> <li>6. Materials (15)</li> <li>7. Waste (5.25)</li> <li>8. Land use &amp; Ecology (10)</li> <li>9. Pollution (12)</li> <li>10. Innovation (10)</li> </ol>	<ol style="list-style-type: none"> <li>1. ecological quality (22.5%)</li> <li>2. economic quality (22.5%)</li> <li>3. socio-cultural and functional quality (22.5%)</li> <li>4. technical quality (22.5%)</li> <li>5. process quality (10%)</li> </ol>	<ol style="list-style-type: none"> <li>1. Energy <ol style="list-style-type: none"> <li>a. Energy performance</li> <li>b. Demand reduction</li> </ol> </li> <li>2. Environment <ol style="list-style-type: none"> <li>a. Water</li> <li>b. Environmental care</li> <li>c. Materials</li> </ol> </li> <li>3. Health <ol style="list-style-type: none"> <li>a. Noise</li> <li>b. Air quality</li> <li>c. Thermal comfort</li> <li>d. Lighting and visual comfort</li> </ol> </li> <li>4. User quality <ol style="list-style-type: none"> <li>a. Accessibility</li> <li>b. Functionality</li> <li>c. Technical quality</li> <li>d. Safety</li> </ol> </li> <li>5. Long term value <ol style="list-style-type: none"> <li>a. Adaptability and future amenities</li> <li>b. Flexibility</li> <li>c. Perceived value</li> </ol> </li> </ol>	<ol style="list-style-type: none"> <li>1. The building's relationship with its immediate environment</li> <li>2. Integrated choice for construction</li> <li>3. Low nuisance worksite</li> <li>4. Energy Management</li> <li>5. Water Management</li> <li>6. Management of activity generated waste</li> <li>7. Servicing &amp; Maintenance</li> <li>8. Hygrometric comfort</li> <li>9. Acoustic comfort</li> <li>10. Visual comfort</li> <li>11. Olfactory comfort</li> <li>12. Health quality of space</li> <li>13. Health quality of air</li> <li>14. Health quality of water</li> </ol>
<b>Impact assessment categories</b>	<ol style="list-style-type: none"> <li>1. Climate change (GWP)</li> <li>2. Water extraction (FW)</li> <li>3. Mineral resource depletion (ADP-Elements))</li> <li>4. Stratospheric ozone depletion (ODP)</li> <li>5. Human toxicity (HTP)</li> <li>6. Ecotoxicity to water (FAETP)</li> <li>7. Nuclear waste</li> <li>8. Ecotoxicity to land (TETP)</li> <li>9. Waste disposal</li> <li>10. Fossil fuel depletion (ADP-Fossil)</li> <li>11. Eutrophication (EP)</li> <li>12. Photochemical ozone creation (PCOP)</li> <li>13. Acidification (AP)</li> </ol>	<ol style="list-style-type: none"> <li>1. Global Warming Potential (GWP)</li> <li>2. Ozone Depletion Potential (ODP)</li> <li>3. Photochemical Ozone Creation Potential (POCP)</li> <li>4. Acidification Potential (AP)</li> <li>5. Eutrophication Potential (EP)</li> <li>6. Risks For The Local Environment (Qualitative)</li> <li>7. Sustainable Use of Resources/Wood (Qualitative)</li> <li>8. Non Renewable Primary Energy Demand (PENren)</li> <li>9. Total Primary Energy Demand and Proportion of Renewable Primary Energy (PEges)</li> <li>10. Drinking Water Demand and Volume of Waste Water (Wkw) (Only use stage)</li> <li>11. Space Demand (Qualitatively using indicators)</li> </ol>	<ol style="list-style-type: none"> <li>1. Abiotic depletion potential, ADP</li> <li>2. Global warming potential, GWP</li> <li>3. Ozone Depletion potential, ODP</li> <li>4. Photochemical oxidant creation potential, POCP</li> <li>5. Human Toxicity Potential, HTP</li> <li>6. Freshwater Aquatic Ecotoxicity, FAETP</li> <li>7. Ecotoxicity sediments</li> <li>8. Terrestrial Ecotoxicity Potential, TETP</li> <li>9. Acidification Potential, AP</li> <li>10. Eutrophication Potential, EP</li> </ol>	<p>Determination of the environmental impact indicators of the construction products, in accordance with EN 15804 or standard ISO 21930:</p> <ol style="list-style-type: none"> <li>1. Abiotic depletion potential (ADP-elements) for non-fossil resources</li> <li>2. Abiotic depletion potential (ADP-fossil fuels) for fossil resources</li> <li>3. Acidification potential of soil and water, AP;</li> <li>4. Depletion potential of the stratospheric ozone layer, ODP;</li> <li>5. Global warming potential, GWP;</li> <li>6. Eutrophication potential, EP;</li> </ol>
<b>Normalisation</b>	Division of the impacts by the annual environmental impacts of one UK citizen, giving all categories the units of "per year"	Normalisation stage to be detailed	Shadow price per year of impact assuming 50-year lifespan	-
<b>Weighting</b>	for individual categories is developed by a panel representing the interest of groups	Weighting of the individual categories with the use of significance factors for criteria	Shadow price per year of impact assuming 50-year lifespan	No weighting of categories. Each is equally weighted to give a profile score.

Source: EURIMA FORCE (2012) and Saskia van Hulst<sup>96</sup>

<sup>96</sup> Saskia van Hulst. *New sustainable building policy in Maastricht*:

[http://www.w-e.nl/Bestanden/bestanden/publicaties/SB10\\_GPR%20Building\\_New%20policy%20Maastricht\\_Final.pdf](http://www.w-e.nl/Bestanden/bestanden/publicaties/SB10_GPR%20Building_New%20policy%20Maastricht_Final.pdf)

**Table 2.9. Example of scoring and weighting of the ecological quality criteria group in DGNB (the criteria group accounts for 22.5% of the total amount of available points)**

Criteria	Criteria points		Weighting factor	Weighted points		Group points		Group performance index
	Max	Achieved		Max	Achieved	Max	Achieved	
Global Warming Potential (GWP)	10	10	3	30	30	200	178.5	89%
Ozone Depletion Potential (ODP)	10	10	1	10	10			
Photochemical Ozone Creation Potential (POCP)	10	10	1	10	10			
Acidification Potential (AP)	10	10	1	10	10			
Eutrophication Potential (EP)	10	7.1	1	10	7.1			
Risks For The Local Environment	10	8.2	3	30	24.6			
Sustainable Use of Resources / Wood	10	10	1	10	10			
Non Renewable Primary Energy Demand	10	10	3	30	30			
Total Primary Energy Demand and Proportion of Renewable Primary Energy	10	8.4	2	20	16.8			
Drinking Water Demand and Volume of Waste Water	10	5	2	20	10			
Space Demand	10	10	2	20	20			

Source: EURIMA FORCE (2012)

#### *Identifying the different methodologies available for assessing the performance of a building*

In order to evaluate the resource efficiency of different building designs there needs to be comparability both in terms of the Bill of Quantities (also sometimes referred to as Bill of Materials), functional requirements and the methodology used. In some cases a Bill of Quantities (BoQ) for a reference building or a preliminary design is provided to bidders within the ITT. This could form a reference building that could be used as the basis for a comparative evaluation by design teams of designs. In other cases, where designs are submitted by different bidders in response to a design specification (e.g. in the case of DB contracts), the performance of these designs could be compared during a competitive process in order to encourage innovative resource efficient designs.

The BoQ for a reference building contains the preliminary evaluation of the amount and cost of main construction materials and products. The BoQ is put together on the basis of the preliminary information included in the concept and detailed design and aims to provide a common basis for bidders to put together their proposals and costings. This information could be used by tenderers to prepare their technical and environmental proposal, including an LCA analysis. Indeed, when the BoQ is provided, it should be possible to make a comparative evaluation of improvements in the life cycle performance of the main building elements.

In order to analyse a building design, tenderers and contractors could, based on our characterisation of the different schemes used across the EU and their associated methodologies, use a number of different approaches. Some are based on the use of EPDs aggregated at a building level; others are more complex (and potentially more comprehensive) as they rely on carrying out an LCA at a building level, thereby allowing for sensitivities to be tested and potential trade-offs to be more easily identified e.g. energy in use phase and energy intensive construction products.

In order to allow for flexibility in what is still an emerging area of expertise, with only early progress towards standardisation, we have identified five options, which could form the basis for ITT's:

- Option 1: Aggregation of Environmental Product Declarations (EPDs), as a core criterion, according to the following methods:
  - 1.1 Aggregation of EPD characterisation results (the raw LCA results for indicators) for each building element, *or*
  - 1.2 Aggregation of weighted EPD scores or ratings (usually a numeric score or letter rating) for each building element. This aggregation could, for example, be carried out with the above-mentioned *Environmental Profiles of Construction Products* within the BREAM scheme
- Option 2: Carry out a Life Cycle Assessment (LCA), as a comprehensive criterion, according to the following methods:
  - 2.1 Impact Category results: The aggregated characterisation results for each indicator obtained using the specified LCA method, representing a standalone LCA study;

2.2 LCA tool score: A single score obtained using a national or regional building LCA tool used by public authorities. This method is employed for example by Greencalc+.

2.3 Building assessment scheme LCA score: A normalised and weighted scoring derived from an LCA-based criterion within a national or regional building assessment and certification scheme used by public authorities. This method is employed for example by the DGNB certification scheme.

Given that comparability is considered to be the most important consideration at the procurement stage, a set of simplified guidelines have been developed with reference to ISO 14040, EN 15978 and EN 15804. These are intended to be used to establish the rules for design teams so that evaluations carried out according to Options 1 or 2 are comparable. A further step is added to ensure that evaluations by design teams are robust by proposing that a technical evaluator should support the procurer.

These guidelines are provided in Annexes I, II and III of the criteria document <sup>97</sup>, and are proposed to be provided together with the GPP criteria document and provide specific information on comparability, technical guidelines and expert evaluation. A brief description and rationale is provided as following.

#### Comparability and uncertainty

Transparency of the results is very important for any analysis using EPDs or LCA. The sources of background data must be made clear, including how it was obtained or compiled, what kind of process and technology it represents and what is included in the data as well as possible sources of uncertainty (Dolezal et al., 2013). Every EPD based analysis or LCA study shall provide:

1. A qualitative assessment of the uncertainties based on the information listed above, together with;
2. A quantitative assessment for the two most significant building elements identified from the analysis (see tables a and b in criterion B10.1).

Current standards deal with uncertainties in similar ways. The EU ILCD handbook and ISO 14044 recommend a completeness check, a sensitivity check to test the accuracy and precision of results and a consistency check. ISO 14044 emphasises the importance of choosing evaluation techniques that are consistent with the goal and purpose of the report.

In order to ensure comparability, the following rules shall be set:

- Option 1: Aggregation of Environmental Product Declarations (EPDs)

All EPDs have to be in conformance with ISO 14025 and have been selected within the same PCR scheme. EPDs can be supplemented by new primary data for building elements subjected to LCA analysis according to the same PCRs. As analysed in the first part of the chapter, some existing building assessment and certification schemes apply normalisation and/or weighting rules to EPDs results in order to generate a comparative score or rating. These rules are optional according to the ISO 14040/14044 and there is no consensus among the scientific community on them. However, as long as the national PCR rules are in compliance with ISO 14025 and/or EN 15804, it would appear feasible to use them on a comparative basis as long as the same system is used by all bidders.

- Option 2: Carry out a Life Cycle Assessment (LCA)

The same LCIA method and Category indicators should be used in the LCA and would have to be specified in the ITT. The selection of Life Cycle Inventory (LCI) data shall follow the quality requirements set out in EN 15978 AND 15804. Verified primary data and supplementary secondary data may be used to fill gaps in the LCI following the guidance in ISO 14040/14044, ISO 14025 (if EPD data is used) and/or EN 15978 and 15804 but the selection and handling of this data, and the assumptions made, would need to be checked by the technical evaluator.

#### Identification of the most significant building elements

The balance between the significance of the production phase and the use phase is dynamic and has been changing as energy requirements have become stricter. Figure 2.9 illustrates for embodied carbon emissions the overall change that has occurred in the UK between 2006 and as projected for 2016/19. The production phase increases marginally as more energy intensive materials are specified whilst the energy use of a building decreases to a position of net zero carbon. The evaluations of the life cycle environmental impacts

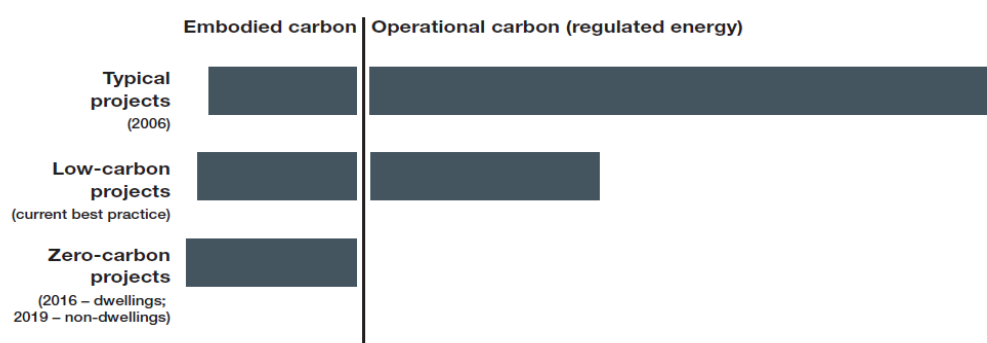
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<sup>97</sup> Annexes I, II and III have been fully reported in section 2.3.1.1.2 Revised criteria proposal

of construction materials and products show that generally some construction products bring more environmental impacts than others.

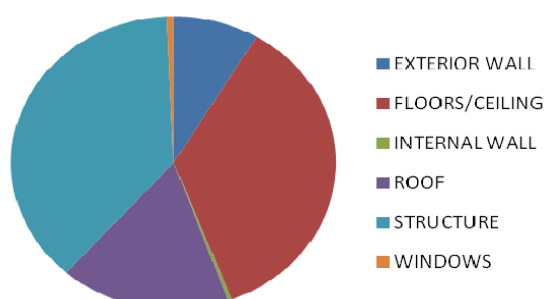
The most significant building elements have been identified according to the outcomes of the technical and environmental analysis developed within the project<sup>98</sup>. For example, the contribution of the different life cycle phases in the overall contribution of the different building elements to the overall normalised and weighted environmental impact of the construction of 1m<sup>2</sup> of office area evaluated for the case study of an office building located in London are reported inSource: JRC-IPTS (2011)

Figure 2.10. Furthermore, literature reviewing LCAs carried out for office buildings, the requirements of the EN 15978 <sup>99</sup> and the EN 15804 <sup>100</sup> standards and the CPA guide <sup>101</sup> have also been considered in the identification of the main building elements.



Source: RICS (2012)

**Figure 2.9 Comparison of the balance of production and use phase embodied carbon emissions over time (2006-2019)**



Source: JRC-IPTS (2011)

**Figure 2.10. Contribution of the different building elements to the overall environmental impact of the construction of 1m<sup>2</sup> of office area for an office building located in London**

In conclusion, the main building elements proposed as a minimum to be analysed for a building design are listed in Table 2.10. According to the ICE Demolition Protocol <sup>102</sup>, a limited number of building elements could be considered for renovations and this principle is also reflected in the two different lists proposed.

<sup>98</sup> JRC IPTS Draft Preliminary Study (2011): <http://susproc.jrc.ec.europa.eu/buildings/docs/Draft%20Report%20Task%203.pdf>

<sup>99</sup> EN 15978: 2011. Sustainability of construction works - Assessment of environmental performance of buildings - Calculation method

<sup>100</sup> EN 15804: 2012 + A1:2013. Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products

<sup>101</sup> CPA (2012): A guide to understanding the embodied impacts of construction products

<http://www.constructionproducts.org.uk/sustainability/products/embodied-impacts/>

<sup>102</sup> ICE Demolition Protocol (2008): <http://www.ice.org.uk/getattachment/eb09d18a-cb12-4a27-a54a-651ec31705f1/Demolition-Protocol-2008.aspx>

**Table 2.10. Identification of the main building elements**

New-build	Renovation
<ul style="list-style-type: none"> <li>- The structural frame, including beams, columns and slabs</li> <li>- External walls, cladding and insulation</li> <li>- Floors and ceilings</li> <li>- Internal walls</li> <li>- Windows</li> <li>- Roofs</li> <li>- Foundations and substructures</li> </ul>	<ul style="list-style-type: none"> <li>- External walls, cladding and insulation</li> <li>- Re-roofing and insulation</li> <li>- Windows</li> </ul> <p>Where additional floors or building extensions are proposed that account for &gt;25% of the existing useable floor area, the list of new-build elements shall also apply.</p>

Defining the building's life cycle, boundaries and functional unit

The following approach was initially proposed for the two criterion options identified:

- Option 1: Aggregation of Environmental Product Declarations (EPDs)

In order ensure that the total environmental impact for each building design can be compared, EPDs have to address cradle to grave life cycles and the declared unit of each EPD has to be multiplied by the appropriate quantity in the bill of materials.

- Option 2: Carry out a Life Cycle Assessment (LCA)

The boundary for the analysis shall be cradle-to-grave (according to ISO 14040). Recycled or re-used materials either as inputs (product stage) or outputs (end of life stage) have to be allocated according to the rules in ISO 14044, Section 4.3.4.3.

As a reference point for each design, the relevant technical and function requirements, the envisaged pattern of use and the requested service life should be the same for each LCA analysis and a common functional unit or reference unit shall be used to present the results (according to ISO 14040/14044).

However, based on the feedback received from stakeholders, both options would need to be used in a way that recognises that there are potential trade-offs between energy use in the manufacturing of construction products and in use of the building. In the case of EPDs, a specific link should be made with the energy criterion B8. This is so that design teams consider the potential trade-offs when designing near zero energy buildings. Whilst in the case of the LCA option, energy in the use phase would be included within the analysis. This is to avoid double counting, hence criterion B8 should not be used. The revised proposal taking into account important potential trade-offs can therefore be illustrated as follows:

- As a trade-off, option 1 EPDs has been linked to the award criterion B8, in order to include the building use phase. Moreover, if option 2 LCA applies, criterion B8 shall not apply in order to avoid double counting of award points

**Award points**

**ENERGY CRITERIA  
(USE PHASE)**

**RESOURCE EFFICIENT  
CONSTRUCTION**

**Core criteria**

**Criterion B8.**  
energy requirements



**Criterion B10.1**  
Option 1 EPDs

**Comprehensive criteria**

~~**Criterion B8.**~~  
~~energy requirements~~



**Criterion B10.1**  
Option 2 LCA

- Option 1 EPDs is proposed as a core criterion, while option 2 LCA is proposed as a comprehensive criterion.

Defining the Life Cycle Impact Assessment (LCIA) Category indicators to be used

In the preliminary study for the development of the GPP criteria, an LCA analysis of three different reference office buildings with three locations Madrid, London and Tallinn, as representative of the three climatic zones

and user behaviours across Europe, was carried out<sup>103</sup>. The reference buildings modelled were specified to be in line with the current Building Regulations in the three locations, as of 2010/11. The environmental impacts calculated per each of the locations and base case office building models are provided in Table 2.11.

The results show that, for the majority of the environmental impact categories, the use phase dominates the environmental impacts, with the exception of abiotic resource depletion. Based on the trend identified in Figure 2.9, and reflecting the timescales in the recast EPBD, the significance of the use phase to new-build projects is likely to continue in the short term until around 2015/16, by which time nearly zero energy buildings will start to be required, thereby shifting the focus towards the production phase. It is to be noted, however, that in some Member States current requirements for the energy performance of buildings may already have the effect of reducing energy use sufficiently to shift the focus onto the production phase.

**Table 2.11. Percentage of the environmental impacts depending on the location and phase of the buildings**

Impact Category	Units (%) kg equiv	MADRID, 30% glazing				LONDON, 30% glazing				TALLINN, 30% glazing			
		Product	Construction	Use	End of life	Product	Construction	Use	End of life	Product	Construction	Use	End of life
GWP	kg CO <sub>2</sub>	8	0	91	0	15	0	85	0	14	0	86	0
ODP	kg CFC 11	12	0	88	0	25	0	75	0	26	0	74	0
AP	kg SO <sub>2</sub>	1	0	99	0	1	0	99	0	1	0	99	0
EP	kg (PO <sub>4</sub> ) <sup>3-</sup>	4	0	95	1	4	0	95	1	4	0	95	1
POF	kg Ethene	1	0	98	0	1	0	98	0	1	0	98	0
ADP	kg Sb	94	0	6	0	95	0	5	0	95	0	5	0
PEC	MJ	6	0	94	0	6	0	94	0	5	0	94	0
WC	m <sup>3</sup>	1	0	99	0	1	0	99	0	1	0	99	0

Note: GWP: green warming potential, ODP: Depletion potential of the stratospheric ozone layer, AP: Acidification potential of land and water, EP: eutrophication potential, POF: Photochemical ozone formation, ADP: Abiotic depletion potential, PEC: primary energy consumption and WC: water consumption

According to several LCA reviews on construction materials and products and on the whole building life cycle<sup>104,105</sup>, the most commonly considered environmental impact categories are global warming potential, acidification, eutrophication and stratospheric ozone depletion. Khasreen et al. (2009) specified that global warming potential is evaluated in almost every study, perhaps because GHG emissions can be more readily quantified than other impacts. Other environmental impact categories such as toxicity, resource depletion potential, land use, water consumption and waste management are also usually identified.

EN 15978 suggests considering the impact category indicators listed in Table 2.12 within a building LCA. These impact categories indicators have been chosen on the basis of agreed calculation methods for their evaluation. According to the EN standard, other indicators, such as human toxicity, eco-toxicity, biodiversity and land use have not been included due to the lack of scientifically agreed and robust calculation methods within the context of LCA.

Of relevance are also the impact category indicators selected in the Assessment of scenarios and options toward a Resource Efficient Europe<sup>106</sup> of the EC under the flagship 2020 initiative, as reported in Table 2.13. Similar impact category indicators can also be seen to have been selected by the most used certification

<sup>103</sup> JRC-IPTS, *Office Buildings: Draft Preliminary Study* (2011)  
<http://susproc.jrc.ec.europa.eu/buildings/docs/Draft%20Report%20Task%203.pdf>

<sup>104</sup> Ortiz et al. (2009). *Sustainability in the construction industry: A review of recent developments based on LCA*. Construction and Building Materials 23, pp. 28–39

<sup>105</sup> Khasreen et al. (2009). *Life-Cycle Assessment and the Environmental Impact of Buildings: A Review*. Sustainability, 1, 674–701

<sup>106</sup> EC (2014). *Assessment of Scenarios and Options towards a Resource Efficient Europe. An Analysis for the European Built Environment*  
[http://ec.europa.eu/environment/enveco/resource\\_efficiency/pdf/TP\\_report.pdf](http://ec.europa.eu/environment/enveco/resource_efficiency/pdf/TP_report.pdf)



schemes for buildings (see Table 2.8) and as now suggested by the new PCR for buildings published in February 2014 by Environdec <sup>107</sup>.

**Table 2.12. Impact category indicators to be included in the LCA according to EN 15978**

Impact assessment categories		Unit
<i>Indicators describing resource use</i>	Use of renewable primary energy excluding energy resources used as raw material	MJ, net calorific value
	Use of renewable primary energy resources used as raw material	MJ, net calorific value
	Use of non-renewable primary energy excluding primary energy resources used as raw material	MJ, net calorific value
	Use of non-renewable primary energy resources used as raw material	MJ, net calorific value
	Use of secondary material	kg
	Use of renewable secondary fuels	MJ
	Use of non-renewable secondary fuels	MJ
	Net use of fresh water	m <sup>3</sup>
<i>Indicators describing environmental impacts</i>	Global Warming Potential, GWP	kg CO2 equiv
	Depletion potential of the stratospheric ozone layer, ODP;	kg CFC 11 equiv
	Acidification potential of land and water; AP;	kg SO2- equiv
	Eutrophication potential, EP;	kg (PO4)3- equiv
	Formation potential of tropospheric ozone photochemical oxidants, POCP;	kg Ethene equiv
	Abiotic Resource Depletion Potential for elements; ADP_elements	kg Sb equiv
	Abiotic Resource Depletion Potential of fossil fuels ADP_fossil fuels	MJ, net calorific value

**Table 2.13. Impact category indicators considered in the Assessment of scenarios and options toward a Resource Efficient Europe**

Impact assessment categories		Unit
<i>Indicators describing materials</i>	Abiotic Resource Depletion Potential for elements; ADP_elements	kg Sb equiv
<i>Indicators describing energy</i>	Abiotic Resource Depletion Potential of fossil fuels ADP_fossil fuels	MJ, net calorific value
	Primary Energy Demand Non Renewable PED-NR	MJ, net calorific value
	Primary Energy Demand Renewable PED-R	MJ, net calorific value
<i>Indicators describing water</i>	Blue Water Consumption BWC	
<i>Indicators describing emissions</i>	Acidification potential AP	kg SO2- equiv
	Eutrophication potential EP	kg (PO4)3- equiv
	Global warming potential GWP	kg CO2 equiv
	Global warming potential excluding biogenic carbon GWP-EB	kg CO2 equiv
	Ozone Depletion Potential ODP	kg CFC 11 equiv
	Photochemical Ozone Creation Potential POCP	kg Ethene equiv

Source: European Commission (2014)

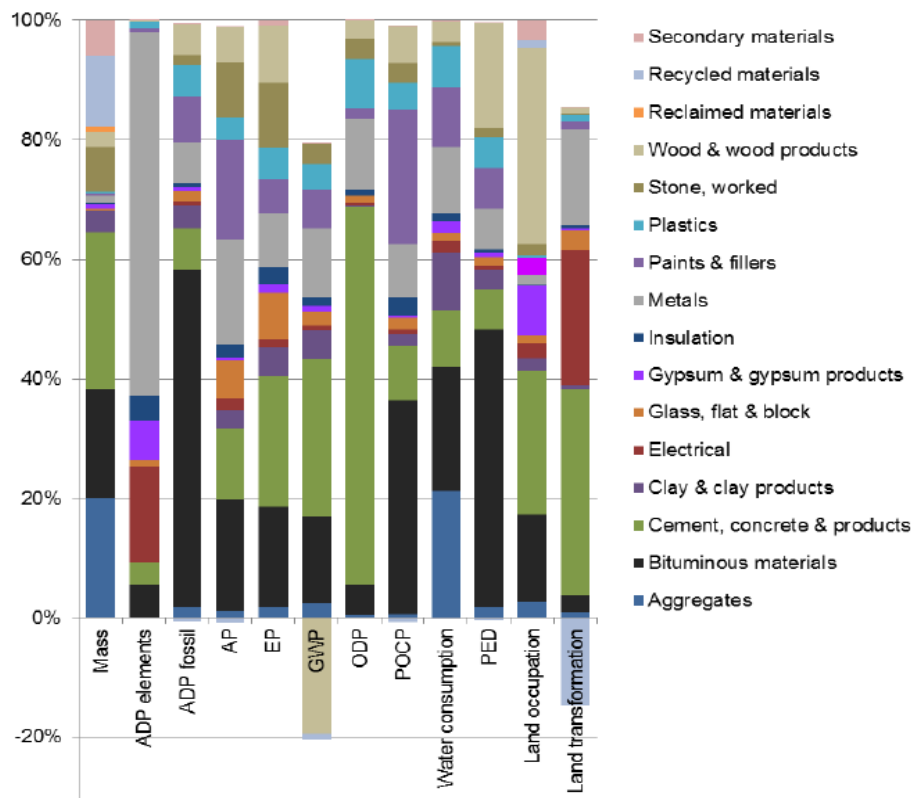
According to Scheuer et al. (2003)<sup>108</sup>, impact indicators such as global warming potential, ozone depletion potential, acidification potential, eutrophication potential and solid waste generation are closely correlated with primary energy demand.

An LCA model for the UK's built environment in a single year has been evaluated in the Assessment of scenarios and options toward a Resource Efficient Europe<sup>109</sup> (unfortunately, a similar level of detail could not be found for Europe as a whole). This analysis indicated that abiotic resource depletion is dominated by the production stage of materials, whilst the use stage of buildings dominates emission related indicators. In the production phase, significant environmental impacts are related to non-metallic minerals and fossil energy materials, as illustrated by Figure 2.11. The study concludes that measures focussing on producing lower-impact products and more resource efficient products have the most potential of environmental impacts reduction within the building sector at the European level.

<sup>107</sup> Environdec Product category rules according to ISO 14025:2006 (2014-02-26) product group: UN CPC 531 buildings. 2014:02 version 1.0 <http://environdec.com/en/PCR/Detail?Pcr=5950&id=158&epslanguage=en>

<sup>108</sup> Scheuer et al. (2003). *Life cycle energy and environmental performance of a new university building: modeling challenges and design implications*. Energy and Buildings 35, pp. 1049–1064

<sup>109</sup> EC (2014) *Assessment of Scenarios and Options towards a Resource Efficient Europe*, An Analysis for the European Built Environment [http://ec.europa.eu/environment/enveco/resource\\_efficiency/pdf/TP\\_report.pdf](http://ec.europa.eu/environment/enveco/resource_efficiency/pdf/TP_report.pdf)



Source: EC, 2014

**Figure 2.11: Environmental impacts associated with the consumption of construction products within the UK built environment** <sup>110</sup>

Stakeholders commented that all the impact category indicators identified in EN 15804/EN 15798 should be used. The impact category indicators from the EN 15804/15978 are listed below, and shall form the basis for a performance comparison of PCRs (option 1) or when carrying out a LCA (option 2):

- Global Warming Potential (GWP),
- Depletion of abiotic resources-elements (ADP elements)
- Depletion of abiotic resources-fossil fuels (ADP fossil fuels)
- Formation potential of tropospheric ozone photochemical oxidants (POCP);
- Depletion potential of the stratospheric ozone layer (ODP);
- Acidification potential of soil and water (AP);
- Eutrophication potential (EP).

Moreover, where an LCA tool is used, only the result for these impact categories are proposed to be taken into account, rather than an aggregated overall score or rating that may be the output.

With reference to the impact assessment models, it is suggested to refer to the characterisation factors identified in the EN 15804 Annex C, as suggested in the EN 15978 and the LCIA models identified in the EN 15804 Annex C.8.

The allocation of CO<sub>2</sub> emissions that may be associated with the production of engineered structural timber products (which can be energy intensive but using biomass) would need to be considered under the GWP category indicator. This could be handled as suggested in ISO 14047 (Example 3) in which carbon sequestration is given a separate category indicator with negative emissions (GWP and GWP Excluding Biogenic).

<sup>110</sup> EC (2014) *Assessment of Scenarios and Options towards a Resource Efficient Europe. An Analysis for the European Built Environment* [http://ec.europa.eu/environment/enveco/resource\\_efficiency/pdf/TP\\_report.pdf](http://ec.europa.eu/environment/enveco/resource_efficiency/pdf/TP_report.pdf)

Whilst some stakeholders expressed disagreement with weightings because there is no consensus, others felt that a weighting should be defined in order to avoid inconsistencies in the comparison of bids. Given the need to be able to make a comparison between the performance of bids, a weighting system for the selected impact category indicators is, on balance, still considered to be important. It is therefore proposed that such a system shall be applied in order to evaluate the overall score.

There is no current system defined for specific use of EN 15978 but various systems are in use within building assessment schemes and LCA methodologies. A weighting system proposed by JRC-IES for use in the development of resource efficiency indicators was reviewed as a potential basis for a recommended set of weightings<sup>111</sup>, but it is based on the ILCD Handbook which adopts different methods and indicators. The criteria weighting of the building assessment scheme SB Tool is understood to refer in part to a weighting system developed by the US EPA, but again this does not provide a clear weighting for the same impact categories<sup>112</sup>.

Given the lack of an agreed weighting system at EU level, it is proposed that the choice of weighting system that shall be used by all bidders shall be made by the contracting authority on the basis of existing weighting systems prescribed by Member States, within building assessment schemes or within other LCA methodologies. These may therefore include a weighting system adopted in a nationally available scheme or a weighting system proposed by the LCA technical evaluator (see the next sub-section and Annex 3).

#### The need for expert evaluation of the design assessments

The lack of experience in the interpretation of the results of the studies and the scope for manipulation of the results suggests that an expert evaluation of design assessments is required. LCA studies are not easy to interpret as the results are provided in the form of indicators, and conclusions can only be drawn considering the local conditions where the building is to be constructed. It is therefore proposed that a technical evaluator specialised in LCA shall assist in preparing the ITT and, once tenders have been received, they will either:

- Carry out a check for how EPDs have been aggregated, or
- Carry out a critical review of the LCAs for methodological choices, data quality and comparability.

A stakeholder commented that the PEF guidance is still only in the pilot phase and therefore should not yet be considered as a valid reference for the purpose of the critical review. In response to this comment a review was therefore made of the EU ILCD handbook in order to see if there already exists concise guidance that could be used by procurers or their technical evaluators. The conclusion was that the guidance contained within the PEF Recommendation is the most concise and easy to refer to, whereas in the ILCD Handbook, it is difficult to find and use, because it is contained within three different sections and a separate review document.

The critical review is therefore proposed to be carried out with reference to ISO 14044, section 6, and the following sections of the European Commission's Product Environmental Footprint (PEF) Recommendation<sup>113</sup>:

- Critical review (section 9, p-68)
- Data collection checklist (Annex III)
- Data quality requirements (section 5.6, p-36)
- Interpretation of results (section 7, p-61)

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<sup>111</sup> European Commission (2012) *Life cycle indicators basket-of-products: development of life cycle based macro-level monitoring indicators for resources, products and waste for the EU-27*, Joint Research Centre, Institute for Environment and Sustainability (IES)

<sup>112</sup> Mateus.R and L.Bragança, *Sustainability assessment and rating of buildings: Developing the methodology SBTool*, Building and Environment 46 (2011) p.1962-1971

<sup>113</sup> 2013/179/EU: Commission Recommendation of 9 April 2013 on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations

#### 2.3.1.1.2 Summary of stakeholder feedback

##### **Stakeholder feedback received during the final written consultation**

Option 1 EPDs scenario has to be cradle to grave: The general opinion was that option 1 is only valid if the environmental impacts of all stages of the life cycle of the building are taken into account, including the use phase, life span and assembly of the building, as well as the induced performance of products. Gains made under the criterion on LCA performance do not necessarily have a detrimental effect on the use-phase performance of the building. Therefore, it was proposed to integrate the criterion with the energy efficiency and recycled content criteria. There was also an opinion expressed that the end-use application of a building element or product cannot be fully known, suggesting the cradle to gate with end of life option would be more appropriate.

Option 1 EPD vs option 2 LCA: Option 2 was considered to be a more robust approach than option 1 and it should be the preferred method for the assessment at the building level. Options 1 and 2 should therefore be covered in separate sections. Moreover, it was considered that the ITT should specify which evaluation method is to be considered, since sub-options (i) and (ii) are not comparable.

Uncertainty: It was commented that it should be added that EPD-based data usually include 20 to 30% uncertainty, depending on the impact indicator. Therefore, differences of 10-15% in the overall environmental impact should be considered as negligible.

Functional unit: It was underlined that a proper identification of the functional unit may help in identifying the main hot-spots, for example m<sup>2</sup>/workstation.

Indicators: It was stressed that the impact category indicators should include all indicators in EN 15804/EN 15978. This would enable sound decisions by the procurer and avoid burden shifting.

Normalisation and Weighting: Some stakeholders asked to provide normalisation and weighting factors in the GPP document as, if they are left open, that may represent an additional source of inconsistencies in interpretation and comparison. Other stakeholders, on the contrary, highlighted that there is no consensus on these factors because they vary according to the MS or LCA method.

Durability: It was suggested to consider the durability of construction products, taking into consideration that a more durable product requires less maintenance/replacement.

*These comments are addressed in the above-given background discussion and rationale.*

### 2.3.1.1.3 Final criteria proposal

Core criteria	Comprehensive criteria								
AWARD CRITERIA									
<p><b>B10.1 Performance of the main building elements</b></p> <p><i>This criterion shall be used in combination with the award core criterion B8.2 Building life cycle GWP, in order to take into consideration the building's use phase.</i></p> <p><i>This criterion <u>may only be applied</u> where a Bill of Quantities<sup>114</sup> for a reference building is to be provided to bidders as the basis for comparison <u>or</u> where designs submitted by different bidders are to be compared during a competitive process.</i></p> <p><i>Additional technical guidance shall be followed during the procurement process, as provided in Annex 1 (EPD option).</i></p> <p><i>A technical evaluator specialised in LCA shall assist in preparing the ITT and shall carry out a critical review of the submissions.</i></p> <p>The procurer shall award points based on the improvement in life cycle performance of the main building elements listed in Table a in comparison with a reference building or other competing designs. This shall be according to option 1 (based on EPDs) as presented below. <i>The basis for the comparison and the option to be used shall be specified in the ITT.</i></p> <p><i>Table a Scope of the building elements to be evaluated</i></p> <table border="1"> <thead> <tr> <th>New-build</th><th>Renovation</th></tr> </thead> <tbody> <tr> <td> <ul style="list-style-type: none"> <li>Foundations and substructures</li> <li>The structural frame, including beams, columns and slabs</li> <li>External walls, cladding and insulation</li> <li>Floors and ceilings</li> <li>Internal walls</li> <li>Windows</li> <li>Roofs</li> </ul> </td><td> <ul style="list-style-type: none"> <li>External walls, cladding and insulation</li> <li>Re-roofing and insulation</li> <li>Windows</li> </ul> <p>Where additional floors or building extensions are foreseen that account for &gt;25% of the existing useable floor area, the list of new-build elements shall also apply.</p> </td></tr> </tbody> </table> <p><b>Option 1: Aggregation of Environmental Product Declarations (EPDs)</b></p> <p>The performance shall be evaluated using Environmental Product Declarations (EPDs) that are in compliance with ISO 14025, EN 15804. The ITT shall specify which of the following three methods shall be used for the evaluation:</p> <ul style="list-style-type: none"> <li>(i) Simplified option: Aggregation of the Global Warming Potential (GWP) indicator results for each building element, declared as CO<sub>2</sub> equivalent emissions;</li> <li>(ii) Indicator results option: Aggregation of the EPD characterisation results (the LCA results for indicators) for each building element, or</li> <li>(iii) Score or rating options: Aggregation of the</li> </ul>	New-build	Renovation	<ul style="list-style-type: none"> <li>Foundations and substructures</li> <li>The structural frame, including beams, columns and slabs</li> <li>External walls, cladding and insulation</li> <li>Floors and ceilings</li> <li>Internal walls</li> <li>Windows</li> <li>Roofs</li> </ul>	<ul style="list-style-type: none"> <li>External walls, cladding and insulation</li> <li>Re-roofing and insulation</li> <li>Windows</li> </ul> <p>Where additional floors or building extensions are foreseen that account for &gt;25% of the existing useable floor area, the list of new-build elements shall also apply.</p>	<p><b>B10.1 Performance of the main building elements</b></p> <p><i>When this criterion is used, the award core criterion B8.1 Minimum Energy performance requirements shall not be used, in order to avoid double counting of the building's use phase.</i></p> <p><i>This criterion <u>may only be applied</u> where a Bill of Quantities<sup>112</sup> for a reference building is to be provided to bidders as the basis for comparison or where designs submitted by different bidders are to be compared during a competitive process.</i></p> <p><i>Additional technical guidance shall be followed during the procurement process, as provided in Annex 2 (LCA options).</i></p> <p><i>A technical evaluator specialised in LCA shall assist in preparing the ITT and shall carry out a critical review of the submissions.</i></p> <p>The procurer shall award points based on the improvement in life cycle performance of the main building elements listed in Table b in comparison with a reference building or other competing designs. This shall be according to option 2 (based on an LCA) as presented below. The basis for the comparison and the option to be used shall be specified in the ITT.</p> <p><i>Table b. Scope of the building elements to be evaluated</i></p> <table border="1"> <thead> <tr> <th>New-build</th><th>Renovation</th></tr> </thead> <tbody> <tr> <td> <ul style="list-style-type: none"> <li>Foundations and substructures</li> <li>The structural frame, including beams, columns and slabs</li> <li>External walls, cladding and insulation</li> <li>Floors and ceilings</li> <li>Internal walls</li> <li>Windows</li> <li>Roofs</li> </ul> </td><td> <ul style="list-style-type: none"> <li>External walls, cladding and insulation</li> <li>Re-roofing and insulation</li> <li>Windows</li> </ul> <p>Where additional floors or building extensions are foreseen that account for &gt;25% of the existing useable floor area, the list of new-build elements shall also apply.</p> </td></tr> </tbody> </table> <p><b>Option 2: Carry out a Life Cycle Assessment (LCA)</b></p> <p>The performance shall be evaluated by carrying out a Life Cycle Assessment (LCA) of the building in accordance with ISO 14040/14044, EN 15978. The ITT shall specify which of the following methods shall be used for the evaluation:</p> <ul style="list-style-type: none"> <li>(i) Impact Category results: The aggregated characterisation results for each indicator obtained using the specified LCA method;</li> <li>(ii) LCA tool score: A single score obtained using a national or regional building LCA tool used by public authorities;</li> <li>(iii) Building assessment scheme LCA score: A normalised and weighted scoring derived from an</li> </ul>	New-build	Renovation	<ul style="list-style-type: none"> <li>Foundations and substructures</li> <li>The structural frame, including beams, columns and slabs</li> <li>External walls, cladding and insulation</li> <li>Floors and ceilings</li> <li>Internal walls</li> <li>Windows</li> <li>Roofs</li> </ul>	<ul style="list-style-type: none"> <li>External walls, cladding and insulation</li> <li>Re-roofing and insulation</li> <li>Windows</li> </ul> <p>Where additional floors or building extensions are foreseen that account for &gt;25% of the existing useable floor area, the list of new-build elements shall also apply.</p>
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<sup>114</sup> Bill of Quantities is defined as 'a list of items giving detailed identifying descriptions and firm quantities of the work comprised in a contract' (RICS 2011)

<p>weighted EPD scores or ratings (usually a numeric score or letter rating) for each building element.</p> <p>The Product Category Rules (PCRs) <sup>115</sup> for the EPDs shall be specified in the ITT and all bidders shall aggregate EPDs from the PCRs, which shall be in accordance with ISO 14025, EN 15804. Only third party verified PCRs shall be used. This shall include verification of primary data.</p> <p>In some Member States there may already be permitting requirements and associated rules for buildings to declare GWP, in which case the bidders shall declare according to these rules. Normalisation and weighting to give a score or rating for building elements shall be permitted where national PCRs have been established in support of building permitting requirements or a building assessment and certification scheme.</p> <p><i>Where analysis using EPDs is carried out prior to procurement of the main contractor, the design team shall provide the contracting authority with a summary of the key technical assumptions used so that they can be included in the tender specifications.</i></p> <p><b>Verification:</b></p> <p>The Design team or the Design &amp; Build tenderer or the DBO tenderer shall provide a bill of materials for the proposed design and the EPD results, which shall be reported according to EN 15804. The comparison with the reference building shall be written up in a concise technical report that compares the proposed design option(s) and calculates the improvement potential. The technical report shall describe how the 'technical points to address' (as set out in Annex 1) have been covered.</p> <p>Where the results from a building assessment and certification system are used, the tenderer's accredited building assessor shall provide verification according to the methodology used by the system.</p> <p><i>The technical report shall be subject to a critical review by the contracting authorities appointed LCA technical evaluator. The critical review shall follow the guidelines in Annex 3.</i></p>	<p>LCA-based criterion within a national or regional building assessment and certification scheme used by public authorities.</p> <p>In each case the methodology shall include, as a minimum, the Lifecycle Impact Category Indicators specified in Annex 2</p> <p><i>Where an LCA analysis is carried out prior to procurement of the main contractor, the design team shall provide the contracting authority with a summary of the key technical assumptions used so that they can be included in the tender specifications.</i></p> <p><b>Verification:</b></p> <p>The Design team or the Design &amp; Build tenderer or the DBO tenderer shall provide a bill of materials for the proposed design and the LCA results, which shall be reported according to ISO 14044 and EN 15978. The comparison with the reference building shall be written up in a concise technical report that compares the proposed design option(s) and calculates the improvement potential. The technical report shall describe how the 'technical points to address' (as set out in Annex 2) have been covered.</p> <p>Where the results from a building assessment and certification system are used, the tenderer's accredited building assessor shall provide verification according to the methodology used by the system.</p> <p><i>The technical report shall be subject to a critical review by the contracting authorities appointed LCA technical evaluator. The critical review shall follow the guidelines in Annex 3.</i></p>
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## Award criteria B10.1: Proposed technical annexes

### Annex 1

#### Supporting guidance for criterion B10.1: Option 1 – Aggregation of EPDs

In detailed design and performance award Criteria B10.1 it was described how Environmental Product Declarations (EPDs) could be used by bidders in order to demonstrate how they would reduce the environmental impact of the construction of an office building. This brief guidance note describes:

- When this criterion can be used;
- The rules required to ensure that bids are comparable; and
- The technical support required for bid selection.

The need for conformity of EPDs with ISO 14025, EN 15804 is also highlighted. However, additional normalisation and

<sup>115</sup> Product Category Rules are required to be followed for the production of each EPD within a scheme. They define how life cycle assessment shall be carried out and verified for each product so as to ensure consistency.

weighting rules within existing building assessment and certification schemes may be used to evaluate designs.

### 1.1 When can EPD option 1 be used?

The use of criteria B10.1 is only recommended where a comparison can be made against a reference building design and/or between different building designs. It is therefore relevant to the following procurement scenarios:

- Where the client already has a reference building design and bill of quantities that has been appraised in order to provide a guide price for comparison with bids;
- Where a design competition is to be used to encourage innovative building designs to be brought forward by design teams and/or contractors;
- Where building designs are required to demonstrate a defined level of environmental performance for specific building elements following rules with an existing building assessment and certification scheme.

In these scenarios, the aggregation of EPDs as the basis for evaluation of performance can be made an award requirement.

### 1.2 Conformity of the EPDs used

EPDs shall be compiled for the listed building elements. These EPDs shall all have been selected from within the same Product Category Rules (PCRs). All EPDs shall be in conformance with ISO 14025, EN 15804.

New primary data for building elements may be used to supplement these EPDs but shall be subject to LCA analysis according to the same PCRs.

Some existing building assessment and certification schemes apply normalisation and/or weighting rules to EPD results in order to generate a comparative score or rating. As long as the main PCR rules are in compliance with ISO 14025, EN 15804, these comparative scores or ratings may be used and each design shall be evaluated according to the system used with the same scheme.

### 1.3 Will additional expertise be required to evaluate bids?

In any bidding process for office buildings, the procurer is likely to require supporting design and technical expertise in order to set requirements and evaluate designs. The procurer may therefore wish to call upon expert input at two main stages:

1. Putting together the design brief and performance requirements: Bidders shall be instructed on what technical requirements they should follow in order to ensure that the designs submitted are comparable.
2. Evaluating designs and improvement options: A technical evaluation of bidders responses to this criteria should be carried out in order to support the procurer.

### 1.4 What instructions should be given to bidders?

The following technical instructions shall be incorporated into the ITT in order to ensure that bids are comparable. Where designs are to be evaluated against a reference building, this shall be clearly stated and quantities of the specified building elements provided.

#### Technical instructions for bidders using EPDs for building evaluations

Technical point to address	What this means in practice
a. Comparability of EPDs	<p>The EPDs shall be selected from within the same Product Category Rules (PCRs). The PCR scheme shall therefore be specified in the ITT.</p> <p>Where the normalisation and/or weighting rules of an EPD system linked to an existing building certification scheme are to be used, each design shall be evaluated according to the same scheme and rules.</p> <p>The level of uncertainty shall be addressed by including 1) a qualitative assessment of the uncertainties based on the sources of background data, how it was obtained or compiled and what kind of process and technology it represents; as well as 2) a quantitative assessment for the two most significant building elements identified from the analysis (see tables a and b in criterion B10.1).</p>
b. Comparison on the basis of functional equivalence	<p>The declared unit, service life and assumptions relating to replacement lifespans shall be those defined within the PCR for the product or building element (see ISO 14025, EN 15804). A common declared unit shall be used to present the results.</p>

c. Building elements within the scope of the criteria	<p>The scope of the criteria shall, as a minimum, comprise the following building elements:</p> <ul style="list-style-type: none"> <li>- Foundations and substructures</li> <li>- The structural frame, including beams, columns and slabs</li> <li>- External walls and insulation</li> <li>- Floors and ceilings</li> <li>- Internal walls</li> <li>- Windows</li> <li>- Roofs</li> </ul>
d. Definition of the building's life cycle and boundaries	<p>EPDs that address cradle to grave shall be compiled. These EPD shall also consider the end of life recycling loads and benefits.</p> <p>Allocation for recycled or re-used materials shall be made according to the following rules:</p> <ul style="list-style-type: none"> <li>- Inputs (product stage): According to the rules in ISO 14044, Section 4.3.4.3.</li> <li>- Outputs (end of life or maintenance stages): According to the rules in EN 15804 section 6.4.3.</li> </ul>
e. Relevance of the results to the whole building	<p>The declared unit for each EPD shall be multiplied by the appropriate quantity in the bill of materials. This is to ensure that the total environmental impact for each building design can be compared.</p>
f. Lifecycle impact category indicators to be used for evaluation purposes	<p>As a minimum, the impact category indicators (referred to as parameters) indicated in EN 15804 shall be used:</p> <ul style="list-style-type: none"> <li>- Global Warming Potential (GWP)</li> <li>- Formation potential of tropospheric ozone photochemical oxidants (POCP);</li> <li>- Depletion potential of the stratospheric ozone layer (ODP);</li> <li>- Acidification potential of soil and water (AP);</li> <li>- Eutrophication potential (EP);</li> <li>- Abiotic Resource Depletion Potential for elements (ADP_elements)</li> <li>- Abiotic Resource Depletion Potential of fossil fuels (ADP_fossil fuels)</li> </ul> <p>Other parameters describing resource use, waste and output flows identified by the EN 15804 can also be, partially or fully, included if they are not already covered within other GPP criteria that are specified, e.g. recycled content, renewable energy generation.</p> <p>A weighting system for the selected impact category indicators shall be applied to evaluate the overall results from the EPD indicators or ratings for the building elements. This system shall be selected by the contracting authority on the basis of:</p> <ul style="list-style-type: none"> <li>- A suitable existing weighting system giving a rating, such as those adopted in some verified PCR schemes,</li> <li>- A weighting system proposed by the LCA technical evaluator (see Annex 3).</li> </ul> <p>Where an LCA tool generates an aggregated score for the Office Building, only the result for these impact categories shall be taken into account.</p>



### **Supporting guidance for criterion B10.1: Option 2 - LCA analysis**

In detailed design and performance requirement award Criterion B10.1 it was described how Life Cycle Assessment (LCA) could be used by bidders in order to demonstrate how they have reduced the environmental impact of an office building's construction. This brief guidance note describes:

- When this criteria can be used;
- The rules required to ensure that bids are comparable; and
- The technical support required for bid selection.

All use of LCA shall be carried out with reference to ISO 14040/ISO 14044, EN 15978.

#### **2.1 When can LCA option 2 be used?**

The use of criteria 10b is only recommended where a comparison can be made of improvement options against a reference building design and/or between different building designs. It is therefore relevant to the following procurement scenarios:

- Where the client already has a reference building design and bill of quantities that has been appraised in order to provide a guide price for comparison with bids:
- Where a design competition is to be used to encourage innovative building designs to be brought forward by design teams and/or contractors:
- Where building designs are required to demonstrate a defined level of performance for specific building components using an LCA-based calculation tool:

In these scenarios an LCA analysis can be made an award requirement.

#### **2.2 Will additional expertise be required to evaluate bids?**

In any tender process for office buildings the procurer is likely to require supporting design and technical expertise in order to set requirements and evaluate designs. The procurer may therefore wish to call upon this expertise at two stages in the procurement process:

1. When putting together the design brief and performance requirements: Bidders shall be instructed on what technical requirements they should follow in order to ensure that the designs submitted are comparable. .
2. When evaluating designs and improvement options: A technical evaluation of tenderers' responses to this criterion should be carried out in order to support the procurer.

A technical evaluator shall be required to carry out a critical review of each tenderers LCA analysis according to the guidance in Annex 3.

#### **2.3 What instructions should be given to bidders?**

The following technical instructions should be incorporated into the ITT in order to ensure that bids are comparable. Where designs are to be evaluated against a reference building, this shall be clearly stated and the bill of materials provided.

#### **Technical instructions for bidders using LCA for building evaluations**

Technical point to address	What this means in practice
a. Method and inventory data	<p>The impact assessment method and life cycle inventory (LCI) data to be used by each design team shall, be specified to ensure comparability.</p> <p>Verified primary data may be used to supplement gaps following the guidance in ISO 14040/14044, EN 15978, and for data from EPDs ISO 14025, EN 15804.</p> <p>The level of uncertainty shall be addressed by including 1) a qualitative assessment of the uncertainties based on the sources of background data, how it was obtained or compiled and what kind of process and technology it represents; as well as 2) a quantitative assessment for the two most significant building elements identified from the analysis (see tables a and b in criterion B10.1).</p>

b. Comparison on the basis of functional equivalence	<p>The following characteristics of the building shall be specified as a reference point for each design (see ISO 14040/14044, EN 15978):</p> <ul style="list-style-type: none"> <li>- Relevant technical and function requirements, as described in the performance requirements;</li> <li>- The envisaged pattern of use;</li> <li>- The requested service life.</li> </ul> <p>A common functional unit or reference unit shall then be used to present the results (see ISO 14040, EN 15987). Service lifetime shall be considered in the definition of the functional unit.</p>
c. Definition of the buildings life cycle and boundaries	<p>The boundary for the analysis shall be cradle-to-grave (see ISO 14040).</p> <p>In the case of a building refurbishment, design teams shall indicatively refer to Module B5 of EN 15978 'boundary for refurbishment'.</p> <p>Allocation for recycled or re-used materials shall be made according to the following rules:</p> <ul style="list-style-type: none"> <li>- Inputs (product stage): According to the rules in ISO 14044, Section 4.3.4.3.</li> <li>- Outputs (end of life or maintenance stages): According to the rules in EN 15804 section 6.4.3.</li> </ul>
d. Building elements within the scope of the criteria	<p>The scope of the criteria shall, as a minimum, comprise the following building elements:</p> <ul style="list-style-type: none"> <li>- Foundations and substructures</li> <li>- The structural frame, including beams, columns and slabs</li> <li>- External walls and insulation</li> <li>- Floors and ceilings</li> <li>- Internal walls</li> <li>- Windows</li> <li>- Roofs</li> </ul>
e. Lifecycle category indicators to be used for evaluation purposes	<p>As a minimum, the impact category indicators indicated in EN 15798 shall be used:</p> <ul style="list-style-type: none"> <li>- Global Warming Potential (GWP)</li> <li>- Formation potential of tropospheric ozone photochemical oxidants (POCP);</li> <li>- Depletion potential of the stratospheric ozone layer (ODP);</li> <li>- Acidification potential of soil and water (AP);</li> <li>- Eutrophication potential (EP);</li> <li>- Abiotic Resource Depletion Potential for elements (ADP_elements)</li> <li>- Abiotic Resource Depletion Potential of fossil fuels (ADP_fossil fuels)</li> </ul> <p>Other indicators describing resource use, waste and output flows identified by the EN 15978 can also be, partially or fully, included if they are not already covered within other GPP criteria that are specified, e.g. recycled content, renewable energy generation.</p> <p>A weighting system for the selected impact category indicators shall be applied in order to evaluate the overall score. This system shall be selected by the contracting authority on the basis of:</p> <ul style="list-style-type: none"> <li>- A suitable existing weighting system, such as the weighting systems adopted in some national LCA schemes, or</li> <li>- A weighting system proposed by the LCA technical evaluator (see Annex 3).</li> </ul>

	Where an LCA tool generates an aggregated scoring for the Office Building, only the result for the impact categories identified in EN 15978, or those shall be taken into account.
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### Annex 3

#### Brief for LCA technical evaluator

The role of the technical evaluator will be to assist the procurer in setting the ground rules for the tenderers, with reference to either Annex 1 or 2, depending on the option chosen.

The technical evaluator shall propose and agree with the contracting authority the weighting of the LCIA indicator results, unless this is already predetermined by options ii or iii in Criterion 10B.1

Once tenders have been received the technical evaluator will either:

- (i) Carry out a check for how EPDs have been aggregated, or
- (ii) Carry out a critical review of the LCAs for methodological choices, data quality and comparability.

The critical review will be carried out with reference to ISO 14044, section 6, and the following sections of the European Commission's Product Environmental Footprint (PEF) Recommendation (2013/179/EU):

- Critical review (section 9, p-68)
- Data collection checklist (Annex III)
- Data quality requirements (section 5.6, p-36)
- Interpretation of results (section 7, p-61).

#### Summary rationale for the final criterion proposal:

- As consequence of initiatives by some Member States and the implementation of the Energy Performance of Buildings Directive the energy performance of new buildings has improved. With the objective of nearly zero energy public buildings by 2018, energy use will decrease further and the relative significance of the embodied impacts of construction materials and products will become more important. This may include the use of more energy and resource intensive products and materials to achieve higher energy performance building fabrics.
- According to the technical and environmental analysis developed within the project, the construction phase is associated with the second most significant environmental impacts after the use phase.
- Several LCA-based tools (developed according to ISO 14040-14044) are widely used in Europe to assess the environmental impact of buildings as a whole and for the selection of construction materials and products. Some of them are EPDs (developed according ISO 14025 and ISO 21930), following the same PCRs. Some examples of the most used schemes across Europe are linked to building assessment schemes (e.g. BREEAM, GPR Buildings, DGNB and HQE) have been described, highlighting assumptions, normalisation and weighting systems, in order to understand the differences between the different methodologies and the potential benefits achievable by means of the use of these tools.
- In conclusion, the evaluation of the improvement in life cycle performance of the main building elements is proposed as an award criterion. Two broad options appear possible for the evaluation of this improvement, within which there are six different variations which would give procurers flexibility depending on the prevailing systems used in a Member State:
  - o Option 1: Aggregation of EPDs as a core criterion
    - 1.1 Aggregation of the GWP indicator results for each building element; or
    - 1.2 Aggregation of EPD characterisation results for each building element; or
    - 1.3 Aggregation of weighted EPD scores or ratings for each building element (as in BREEAM).
  - o Option 2: Carry out a Life Cycle Assessment (LCA) as a comprehensive criterion according to one of the following methods:

2.1 Impact Category results: The aggregated characterisation results for each indicator obtained using the specified LCA method; or

2.2 LCA tool score: A single score obtained using a national or regional building LCA tool mandated for use by public authorities (such as GPR Buildings); or

2.3 Building assessment scheme LCA score: A normalised and weighted scoring derived from an LCA-based criterion within a national or regional building assessment and certification scheme used by public authorities (such as DGNB).

- It is necessary to ensure comparability between the analyses by means of using EPDs developed in conformance with ISO 14025 and/or EN 15804 and by referring to EPDs following the same PCR scheme (option 1) or by using the same LCIA method and life cycle inventory (LCI) data (option 2). Moreover, it is considered that, in order to incorporate consideration of the life cycle of the building, the cradle-to-grave scenario shall be set as the requirement for EPDs, reflecting as it does the service life of the building as well as the maintenance, replacement cycle and end of life for the products or (preferably) whole building elements.
- Award criterion B8 has been updated in order to combine the Global Warming Potential (GWP) from the use phase and the main building elements. Points would then be awarded to the lowest combined GWP. The aim of this is to encourage bidders to take into account the likely trade-off between use phase and product performance. This is supported by the simplest life cycle performance Option 1.1.
- The LCA analysis in option 2 has at least to consider the main building elements, which have been identified according to the outcomes of the technical and environmental analysis, the requirements of the EN 15978 and the EN 15804 standards and the CPA guide. Elements are proposed because these are most recognisable to design teams, forming the basis for the Bill of Quantities for a building and the increasing used of whole systems for parts of a building e.g. façade, glazing, structures. Moreover, if required, they can be disaggregated into constituent products and materials.
- Based on a review of category indicators selected in LCA studies, the following categories indicated in the EN 15804/15978 have been selected in order to reflect impacts during the production phase and to compare the bid designs – Global Warming Potential, the formation potential of tropospheric ozone photochemical oxidants, the depletion potential of the stratospheric ozone layer, the acidification potential of soil and water, the eutrophication potential, the depletion of abiotic resources-elements and of abiotic resources-fossil fuels. These shall be included, as a minimum, in PCRs (option 1) or when carrying out an LCA (option 2).
- Additional notes on the selection of the functional unit are included in the separate procurement guidance document that accompanies the GPP criteria.

### **2.3.1.2 At what stage of the procurement process are the criteria relevant?**

The evaluation of the performance of the main building elements has been proposed as an award criterion (both Core and Comprehensive criterion) to be applied during the detailed design and performance requirements procurement phase. The *Design team* or the *Design & Build tenderer* or the *DBO tenderer* shall provide a bill of materials for the proposed design. The comparison of the proposed design option(s) and the calculation of the improvement potential with the reference building shall be written up in a concise technical report. This comparison may only be applied where a bill of materials for a reference building is provided to bidders in the ITT as the basis for comparison or where designs submitted by different bidders are to be compared during a one or two stage competitive process.

An LCA technical evaluator appointed by the contracting authorities shall provide a critical review of the technical report, according to the rules provided in the section 2.2.1.1. Moreover, guidelines for the critical review are also provided in Annex III enclosed to the GPP criteria document.

The criteria classification, their reference numbers in the criteria document and the respective procurement phase can be cross-referenced as follows.

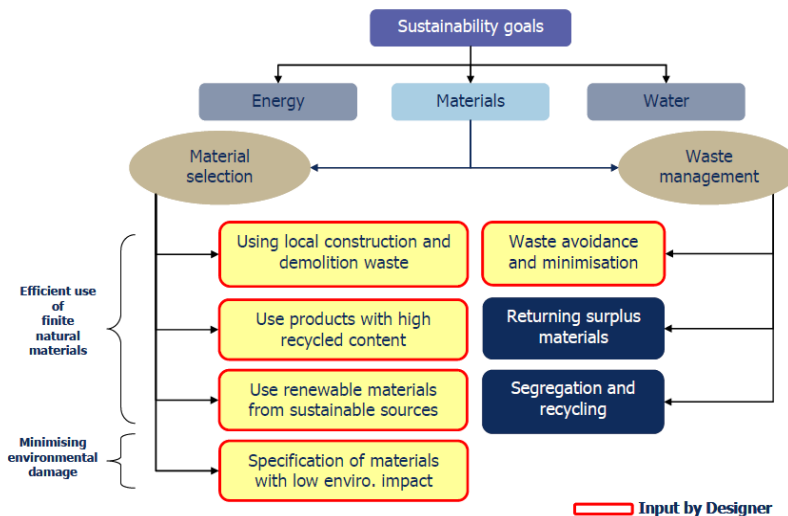
Title of the criterion	Procurement phase	Criterion classification	Criteria typology	Reference number in the criteria document
Performance requirements of the main building elements	B. Detailed design and performance requirements	Core and Comprehensive	Award criterion	B10.1

## 2.3.2 Recycled content

### 2.3.2.1 Incorporation of recycling content

#### 2.3.2.1.1 Background technical discussion and rationale

Energy, water and material use are the three key areas where the construction industry needs to increase its resource efficiency. In Figure 2.12 the various ways in which efficient use of materials directly contributes to greater sustainability in construction are highlighted<sup>116</sup>.



Source: WRAP (2009)

**Figure 2.12: Materials selection and use is a key element of sustainable construction**

According to the European Commission's Reference Document on Best Environmental Management Practice in the building and construction sector<sup>117</sup>, the use of materials with high recycled content is one of the best practices with the potential for greatest influence on resource efficiency in construction and should be taken into consideration by contracting authorities, project teams and relevant stakeholders during the procurement process. Moreover, it is claimed that recycled content can be checked along the supply chain, although in the absence of harmonised systems and protocols for declaration and traceability for most products and materials, this may be more difficult in some Member States.

Recycled content is defined by ISO 14021, which is a standard for Type II self-declarations by manufacturers, as the proportion, by mass, of recycled material in a product or packaging. In general, a reference to recycled content includes re-used products and materials. Industrial by-products as defined by art. 5 of the Waste Framework Directive<sup>118</sup> can also be classed as recycled content.

Employing more re-used and recycled material in construction is a significant way of making a contribution to resource efficiency by diverting materials from landfill and saving natural resources. Contractors and designers can make major improvements in materials efficiency, by minimising waste generation in construction, maximising the recycling rate, reusing materials and selecting construction products with a higher recycled content and lower embodied impacts.

<sup>116</sup> WRAP Delivering higher recycled content in construction projects (2009):

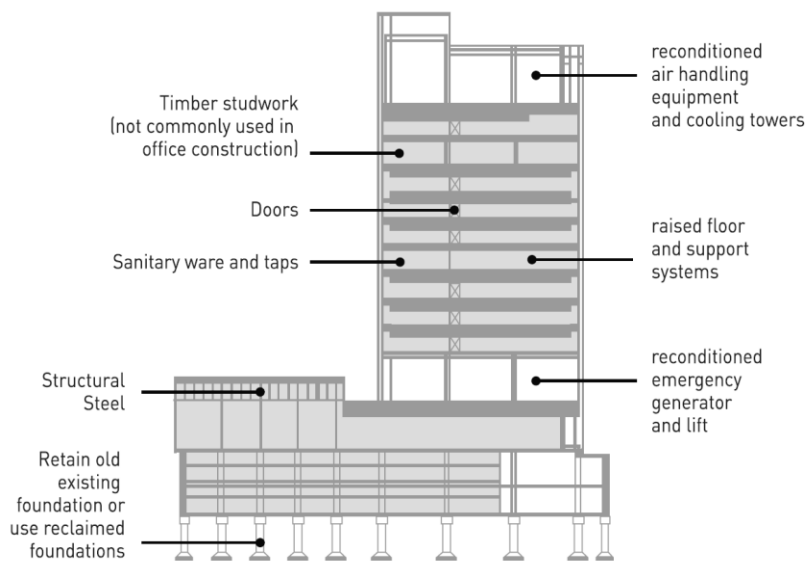
[http://www2.wrap.org.uk/downloads/Delivering\\_higher\\_recycled\\_content\\_in\\_construction\\_projects.a5cddb03.5021.pdf](http://www2.wrap.org.uk/downloads/Delivering_higher_recycled_content_in_construction_projects.a5cddb03.5021.pdf)

<sup>117</sup> EC Reference Document on Best Environmental Management Practice in the building and construction sector (2012):

<http://susproc.jrc.ec.europa.eu/activities/emas/documents/ConstructionSector.pdf>

<sup>118</sup> Waste Framework Directive (WFD) 2008/98/EC: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:312:0003:0030:en:PDF>

In Figure 2.13 an example of the most common opportunities to incorporate re-used and recycled materials into a typical office building is shown<sup>119</sup>.



Source: WRAP (2007)

**Figure 2.13: Opportunities to incorporate reclaimed materials into a typical office building**

According to a literature review, product types that commonly offer higher levels of recycled content tend to include:

- Bulk aggregates (sub-base, pipe bedding, fill, etc.)
- Pre-cast concrete (paving, slabs)
- Ready mix concrete
- Concrete tiles
- Dense blocks
- Lightweight blocks
- Bricks
- Insulation materials (floor, wall and roof)
- Plasterboard
- Floor coverings (carpet, underlays, etc.)
- Wooden floor coverings
- Paint and varnishes

Requiring a minimum of 10 to 15% recycled content by value for the project overall is broadly achievable according to literature <sup>120, 121, 122</sup>. In order to make best use of the data on material quantities and costs commonly available to the contracting authority and the design team, the most practical indicator is the

<sup>119</sup> WRAP, *Reclaimed building products guide*,

[http://www2.wrap.org.uk/downloads/Reclaimed\\_building\\_products\\_guide.c5526607.5259.pdf](http://www2.wrap.org.uk/downloads/Reclaimed_building_products_guide.c5526607.5259.pdf)

<sup>120</sup> EC Reference Document on Best Environmental Management Practice in the building and construction sector (2012):

<http://susproc.jrc.ec.europa.eu/activities/emas/documents/ConstructionSector.pdf>

<sup>121</sup> WRAP Delivering higher recycled content in construction projects (2009):

[http://www2.wrap.org.uk/downloads/Delivering\\_higher\\_recycled\\_content\\_in\\_construction\\_projects.a5cddb03.5021.pdf](http://www2.wrap.org.uk/downloads/Delivering_higher_recycled_content_in_construction_projects.a5cddb03.5021.pdf)

<sup>122</sup> BIOIS, EC (2011). Service Contract on Management of Construction and Demolition Waste – SR1. Final Report Task 2. Available online at [http://ec.europa.eu/environment/waste/pdf/2011\\_CDW\\_Report.pdf](http://ec.europa.eu/environment/waste/pdf/2011_CDW_Report.pdf)

recycled content by value. Calculation by mass would require access to data that is not usually included in cost plans and Bills of Quantities (BoQ).

In UK organisation WRAP's report *Delivering higher recycled content in construction projects* (2009), the findings of case studies undertaken for a broad range of building types are presented, as is shown in Table 2.14. In detail, this underlines that most buildings contain greater than 10% recycled content by value using standard products. Moreover, by using cost-neutral good practice and readily available construction products with higher recycled content, an overall percentage of 15-30% recycled content by value could be easily obtained.

**Table 2.14: Recycled content as a percentage of the total material cost for a selection of building types** <sup>123</sup>

Type of project	Using standard practice products	Using cost-neutral good practice
Commercial retail	11–32%	21–44%
Commercial offices	10–22%	12–30%
Education, healthcare	12–20%	15–30%
Residential	6–26%	16–31%
Infrastructure	8–36%	25–49%

As reported in Table 2.15, data compiled from a number of different projects and studies illustrates that the level of recycled content (by mass) can vary widely from very low levels, according to standard materials used in the market, to very high levels which can be considered to represent good or best practices in the market. Standard practice represents the baseline level at which the lowest recycled content is normally achieved. Good practices with higher level of recycled content are available in the market and are achievable at no or limited additional costs. Moreover, information is given also on the best practice level, in which the highest recycled content is generally achievable, based on the evidence reviewed, at additional cost. Even though it is not possible to generalise the results provided by these examples, they provide an indication of the feasible level of recycled content in currently used construction materials and products.

**Table 2.15: Example of recycled content used in construction materials in different practices**

	Standard practice (% by mass)	Good practice (% by mass)	Best practice (% by mass)
Brick and dense blocks	0-50 <sup>c</sup> 30 <sup>b</sup> 0-70 <sup>d</sup>	50-80 <sup>c</sup>	60-90 <sup>c</sup>
Ceiling materials	10-36 <sup>c</sup> 10-52 <sup>d</sup>	50-84 <sup>c</sup>	78-98 <sup>c</sup>
Concrete tiles	0-43 <sup>c</sup> 0-17 <sup>d</sup>	5-80 <sup>c</sup>	10-95 <sup>c</sup>
Aggregates	0-50 <sup>c</sup>	25-80 <sup>c</sup>	100 <sup>c</sup>
Mortar	3 <sup>c</sup>	4 <sup>c</sup>	70 <sup>c</sup>
Concrete	0-25 <sup>c</sup> 10-20 <sup>b</sup>	5-30 <sup>c</sup>	23-90 <sup>c</sup>
Insulation (mineral/glass wool)	25-30 <sup>c</sup>	50-80 <sup>c</sup>	80 <sup>c</sup>
Plasterboard	0 <sup>b</sup>	25-30 <sup>b</sup>	
<sup>a</sup> EC JRC <sup>124</sup> <sup>b</sup> EC Biois 2011 <sup>125</sup>		<sup>c</sup> WRAP 2008 <sup>126</sup> <sup>d</sup> WRAP 2009 <sup>127</sup>	

<sup>123</sup> WRAP Delivering higher recycled content in construction projects (2009):

[http://www2.wrap.org.uk/downloads/Delivering\\_higher\\_recycled\\_content\\_in\\_construction\\_projects.a5cddb03.5021.pdf](http://www2.wrap.org.uk/downloads/Delivering_higher_recycled_content_in_construction_projects.a5cddb03.5021.pdf)

<sup>124</sup> EC Reference Document on Best Environmental Management Practice in the building and construction sector (2012):

<http://susproc.jrc.ec.europa.eu/activities/emas/documents/ConstructionSector.pdf>

<sup>125</sup> BIOIS, EC (2011). Service Contract on Management of Construction and Demolition Waste – SR1. Final Report Task 2. Available online at [http://ec.europa.eu/environment/waste/pdf/2011\\_CDW\\_Report.pdf](http://ec.europa.eu/environment/waste/pdf/2011_CDW_Report.pdf)

<sup>126</sup> WRAP Choosing construction products. Guide to the recycled content of mainstream construction products (2008):

<http://www.wrap.org.uk/sites/files/wrap/Const%20Product%20Guide%20Version%204.1.pdf>

<sup>127</sup> WRAP Delivering higher recycled content in construction projects (2009):

[http://www2.wrap.org.uk/downloads/Delivering\\_higher\\_recycled\\_content\\_in\\_construction\\_projects.a5cddb03.5021.pdf](http://www2.wrap.org.uk/downloads/Delivering_higher_recycled_content_in_construction_projects.a5cddb03.5021.pdf)

With the high recycled content by mass collected in Table 2.15, most projects can exceed 10% recycled content by value with minimal effort. Moreover, by setting this minimum requirement, construction clients can motivate their design team and contractors to become aware of their current performance and then identify the most significant opportunities to improve that performance<sup>128</sup>. By adopting the available opportunities to increase recycled content through the use of cost competitive, readily available products (i.e. 'good practice' at no extra costs), levels exceeding 15–20% are common.

Choosing to use products with a higher recycled content and to achieve a high level of performance for the total Bill of Materials is more challenging. For example, specifications for concrete may imply higher levels of quality control on performance from suppliers and monitoring on site. In some cases it may also imply changes in on-site practices e.g. longer curing times to achieve the same performance.

On the basis of the information reviewed, award criteria could be proposed to encourage the further incorporation of recycled content into the main building elements (either individually or in total) as defined in Table 2.15 and into the finishing elements used in the fit-out, which shall obviously be weighted lower than the main building elements in the evaluation.

As a Core award criterion, points could be proposed in proportion to incorporation of the recycled content and/or industrial by-products greater than a minimum of 15% by value into the main building elements and the most relevant finishing elements, which on the basis of the literature review, have been identified in:

- Ceiling tiles
- Textile floor and wall coverings
- Laminate and flexible floor coverings
- Wooden floor coverings

As Comprehensive award criterion, points are proposed in proportion to incorporation of the recycled content, re-used content and industrial by-products greater than a minimum of 30% by value into the main building elements and the finishing elements.

#### Taking account of transport impacts

Stakeholders highlighted the importance of taking into account the transport impacts linking the recycled content criterion to materials transportation, considering in particular the mode of transport and CO<sub>2</sub> emissions. This is because recycled content may not always equate to an environmental improvement, as bulk materials, such as recycled coarse aggregates, may have to be transported over longer distances than virgin materials.

For this reason, it is important to take account of the possible trade-off by either,

- At the most basic level: requiring consideration of only the CO<sub>2</sub>e emissions from materials transportation (see scenario 3 in Figure 2.14 and Section 2.1.8);
- An intermediate level: combining the CO<sub>2</sub>e emissions from materials transportation with a recycled content requirement (see scenario 2 in Figure 2.14), or;
- At the most ambitious level: evaluating the impacts holistically by including within the ITT a criterion on the life cycle impacts of materials i.e. criterion 10.1 which is EPD or LCA based (see scenario 1 in Figure 2.14).

The preferred option would be the most ambitious, with in both options the mode of transport considered within the life cycle inventory data analysed. The proposed interrelationship between the criteria options is illustrated in Figure 2.14.

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<sup>128</sup> WRAP, *Recyclability efficiency metric*, January 2008, <http://www.wrapni.org.uk/sites/files/wrap/Recyclability%20Efficiency%20Metric.pdf>



Award points	Core criteria	Comprehensive criteria
<b>Scenario 1</b>		
<b>LCA PERFORMANCE</b>	<b>Criterion B 10.1</b> EPDs	<b>Criterion B 10.1</b> LCA
<b>Scenario 2</b>		
<b>RECYCLED CONTENT + MATERIALS TRANSPORTATION</b>	<b>Criterion B10.2</b> RC > 15% + <b>Criterion B10.3</b> CO <sub>2</sub> e/t transp.	<b>Criterion B10.2</b> RC > 30% + <b>Criterion B10.3</b> CO <sub>2</sub> e/t transp.
<b>Scenario 3</b>		
<b>MATERIALS TRANSPORTATION</b>	<b>Criterion B10.3</b> CO <sub>2</sub> e/t transp.	<b>Criterion B10.3</b> CO <sub>2</sub> e/t transp.

**Figure 2.14 Proposed interrelation between the recycled content criterion and the EPD/LCA criterion or the material transportation criterion**

Although it is proposed that if criterion 10.1 is used then a criterion on recycled content shall not be used, it is considered that there may be local circumstances that still warrant the setting of specific recycled content requirements in an ITT. This may, for example, reflect local natural resource constraints as set out in a minerals plan, or landfill diversion targets which may reflect local waste management constraints as set out in a waste plan.

#### Monitoring and verification of recycled content during construction

Under the Construction Products Regulation (CPR - 305/2011/EU)<sup>129</sup>, several products with recycling potential are covered by harmonised European standards (hEN). Currently these standards are covering the performance of a product per se (e.g. structural stability, fire safety, emission of dangerous substances) no matter if the materials used are primary or secondary materials. However, the ongoing discussion at EU and national level on covering environmental performance in hENs and the development of horizontal product category rules (PCR) in a European standard (15804) has motivated several technical committees in CEN to assess if and how reliable information on recycled content could be addressed in specific hENs for construction products.

Products covered by harmonised European standards that might have significant potential of using recycled materials are:

- Rc = Concrete, concrete products, mortar & concrete masonry units
- Ru = Unbound aggregate, natural stone & hydraulically bound aggregate
- Rb = Clay masonry units (i.e. bricks and tiles), calcium silicate masonry units & aerated non-floating concrete
- Rg = Glass

Having this information reported makes the identification of the recycled content easier. In the UK, for example, the application of an End-of-Waste Quality Protocol for recycled and secondary aggregates<sup>130</sup> has provided a benchmark for standards, giving aggregate users the confidence that recycled and secondary materials are of the required quality and are equivalent to primary, or natural, materials supporting an increased use of recycled content in the building sector.

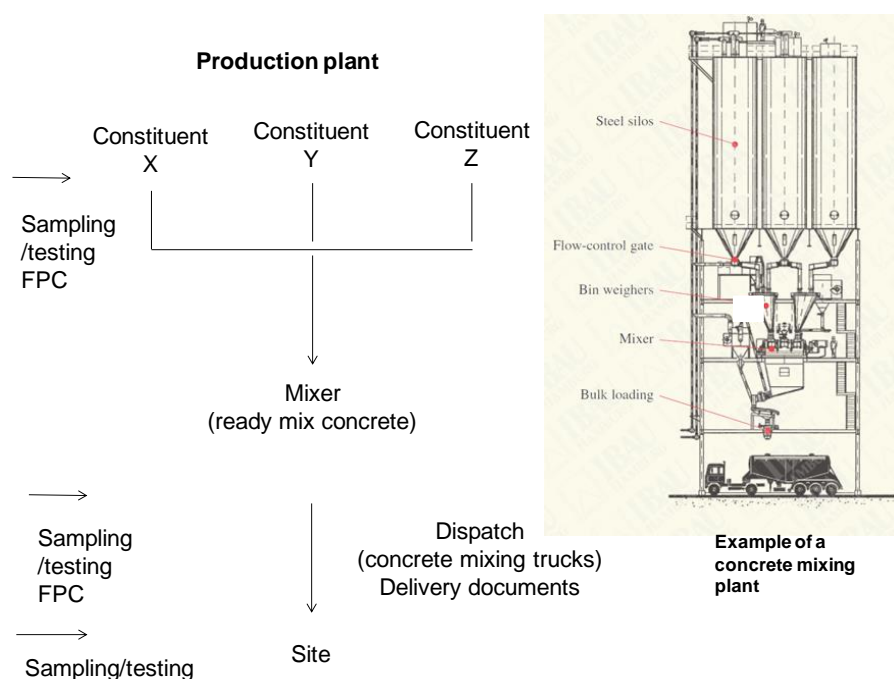
<sup>129</sup> Construction Products Regulation (CPR) 305/2011/EU: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:088:0005:0043:EN:PDF>

<sup>130</sup> DEFRA, WRAP Quality Protocol. Aggregates from inert waste (2013): [http://www.mineralproducts.org/documents/aggregates\\_quality\\_protocol.pdf](http://www.mineralproducts.org/documents/aggregates_quality_protocol.pdf)

Whilst an annual production average for a dedicated production line is understood to be readily verifiable, further feedback has been collected from stakeholders on whether batch production to a specified content can be accurately verified. An approach based on a mass balance for a product batch from which deliveries are made to a site (for example, ready mix concrete for which samples from each batch are tested before dispatch) or the factory production of specific product lines with claimed content levels (for example, a block work or insulation product) is proposed. A batch is considered to represent a quantity of product manufactured by the same process under the same conditions and labelled in the same manner.

For example, the harmonised European standards on concrete (EN 206) lay down requirements for concrete and the methods of verification for delivering fresh concrete, for conformity control, for the production control and for conformity evaluation. Information on the identification of the producer, constituent materials (aggregates, binder, filler, additives), the mix design formulation, etc. have to be provided. This covers equally mix designs with natural or recycled material inputs.

A schematic of a production plant in which different constituents are mixed to produce a materials batch that is delivered to site is represented in Figure 2.15. Moreover, the production control comprises all measures necessary to maintain the properties of concrete in conformity to specified requirements. It includes selection of constituents, concrete composition, concrete production, inspections and tests, etc. This level of production control, in combination with the test report and the presence of Accredited Bodies, is considered sufficient to provide verification where there is recycled content in each concrete batch from which deliveries are dispatched to a construction site..



**Figure 2.15: Scheme of a concrete production plant and dispatch to site**

It is therefore proposed that, during the design phase, the proportional contribution of the recycled content and/or re-used content to the overall weight of the specified building elements shall be quantified. Tenderers for the main contractor, the DB or DBO contractors shall describe how the total recycled content will be calculated and verified, including, as a minimum, examples of batch documentation, factory production control documentation and delivery documentation, and how the third party verification will be arranged during the construction phase. In this latter phase, all the certificates providing information would have to be collated, including product data sheets, data from test reports and supporting certificates for recyclates.

### 2.3.2.1.2 Summary of stakeholder feedback

#### Stakeholder feedback received during the final written consultation and final criteria proposal

The proposed criterion on recycled content: Some stakeholders considered that because it is not always a given that recycled material has the least environmental impact. It was stressed that transportation distances and variability in the recycled materials availability should be considered. It was also suggested to award points for carrying out an analysis of local availability of recycled material or, alternatively, to use a responsible sourcing scheme, such as BES 6001 or the scheme being developed by the Concrete Sustainability Council. Some stakeholders also highlighted that recycled content is not a resource efficiency indicator, but a tool that might lead to higher resource efficiency. They emphasised that a building product / element might not have any recycled content but may offer advantages in terms of structural strength, durability, thermal performance, weight etc. that lead to a lower resource use over the life cycle of the whole building.

Recycled content evaluation: Some stakeholders considered that the proposed calculation method was not feasible for insulation materials production lines that are usually flexible and able to make many different products. For this kind of materials, they emphasised that it should be clarified what is meant by “reuse”. If the product has to comply with the Waste Framework Directive, this was not considered to be economically viable and would also require a verification of hazardous substances potentially contained in the product (which might prevent re-use).

Verification process: It was considered by some stakeholders that this could be very costly, particularly for SMEs, even more so as it involves third-party checks. Moreover, if the recycled content is chemically reacted in a product, it is impossible to trace it back to its origin.

Including glazing in the recycled content evaluation: A stakeholder emphasised that glazed elements are fully recyclable and the production of new glass products presents an important opportunity for the use of recycled glass.

*These comments are addressed in the above-given background discussion and rationale.*

### 2.3.2.1.3 Final criteria proposal following written consultation

Core criteria	Comprehensive criteria
<b>AWARD CRITERIA</b>	
<p><b>B10.2 Incorporation of recycled content in concrete and masonry</b></p> <p><i>This criterion shall be used where a concrete and masonry structural solution is to be designed by all bidders. It is recommended to consider combining it with criterion B10.3, but should not be used if criterion B10.1 is selected <sup>131</sup></i></p> <p><i>This criterion is applicable to office buildings with concrete structural frames, blockwork walls and in-fill and masonry internal and external walls.</i></p> <p>The procurer shall award points to tenderers that achieve greater than or equal to 15% by value of recycled content and/or by-products<sup>132</sup> for the sum of the main building elements in Table c.</p> <p><i>The minimum content requirement could be set higher if agreement is reached with the design team prior to tendering for the main contractor.</i></p> <p><i>Table c. Scope of the building elements to be included</i></p>	<p><b>B10.2 Incorporation of recycled or re-used content in concrete and masonry</b></p> <p><i>This criterion shall be used where a concrete and masonry structural solution is to be designed by all bidders. It is recommended to consider combining it with criterion B10.3, but should not be used if criterion B10.1 is selected <sup>129</sup></i></p> <p><i>This criterion is applicable to office buildings with concrete structural frames, blockwork walls and in-fill and masonry internal and external walls.</i></p> <p>The procurer shall award points to tenderers that achieve greater than or equal to 30% by value of recycled content, re-used content and/or by-products<sup>130</sup> for the sum of the main building elements in Table d.</p> <p><i>The minimum content requirement could be set higher if agreement is reached with the design team prior to tendering for the main contractor.</i></p> <p><i>The contracting authority may choose to allocate more points to re-used content according to the local conditions.</i></p>

<sup>131</sup> If specific local conditions and planning policies support the use of recycled content, the contracting authority can evaluate, on a case by case basis, the possibility to include a criterion on recycled content within the ITT alongside the holistic criterion B10.1 EPD/LCA. The assumptions and life cycle inventory data relating to the production and construction phase of the recycled materials would need to be included in the response to B10.1.

<sup>132</sup> A by-product is defined in art. 5 of the Waste Framework Directive as ‘A substance or object, resulting from a production process, the primary aim of which is not the production of that item.....’

<table border="1"> <thead> <tr> <th>New-build</th><th>Renovation</th></tr> </thead> <tbody> <tr> <td> <ul style="list-style-type: none"> <li>- The structural frame, including beams, columns and slabs</li> <li>- External walls</li> <li>- Floors and ceilings</li> <li>- Internal walls</li> <li>- Roofs</li> <li>- Foundation and substructure</li> </ul> </td><td> <ul style="list-style-type: none"> <li>- External walls</li> <li>- Internal walls</li> <li>- Re-roofing</li> </ul> <p>Where additional floors or building extensions are foreseen that account for &gt;25% of the existing useable floor area, the list of new-build elements shall also apply.</p> </td></tr> </tbody> </table>	New-build	Renovation	<ul style="list-style-type: none"> <li>- The structural frame, including beams, columns and slabs</li> <li>- External walls</li> <li>- Floors and ceilings</li> <li>- Internal walls</li> <li>- Roofs</li> <li>- Foundation and substructure</li> </ul>	<ul style="list-style-type: none"> <li>- External walls</li> <li>- Internal walls</li> <li>- Re-roofing</li> </ul> <p>Where additional floors or building extensions are foreseen that account for &gt;25% of the existing useable floor area, the list of new-build elements shall also apply.</p>	
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<p>The recycled content shall be calculated on the basis of an average mass balance of recycled materials and/or by-products according to how they are produced and delivered to site (<i>as applicable</i>):</p> <ul style="list-style-type: none"> <li>• The total number of ready mixed batches delivered to site in accordance with EN 12620 (aggregates for concrete) and EN 206 (concrete);</li> <li>• On an annual basis for factory made panels, columns, blocks and elements with claimed content levels in accordance with EN 12620 (aggregates for concrete) and EN 206 (concrete);</li> </ul> <p><b>Verification:</b> The tenderers for main contractor, the Design &amp; Build contractor <i>or</i> the DBO contractor shall propose the total recycled content quantifying the proportional contribution of the total recycled content to the overall value of the specified building elements, based on the information provided by the producer (s) of the construction product.</p> <p>The tenderers for main contractor, the Design &amp; Build contractor <i>or</i> the DBO contractor shall describe how the overall value will be calculated and verified, including, as a minimum, batch documentation, factory production control documentation and delivery documentation, and how the third party verification will be arranged during the construction phase.</p> <p><i>The ordering and delivery to site of these building elements shall later be verified by the main construction contractor (see Section D6).</i></p>					
<p><i>This could include favouring designs that re-use the primary load bearing structure of an existing building.</i></p>					
<p><i>Table d. Scope of the building elements to be included</i></p>					
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<p><b>CONTRACT PERFORMANCE CLAUSES</b></p>					
<p><b>D6. Incorporation of recycled content</b></p> <p>As materials are ordered and brought onto site, recycled content claims shall be verified for each batch of product <sup>133</sup>.</p> <p>The main construction contractor <i>or</i> the DBO contractor shall verify claims by obtaining information from supplier(s) of the construction products used. This shall</p>	<p><b>D6. Incorporation of recycled or reused content</b></p> <p>As materials are ordered and brought onto site, recycled or re-used content claims shall be verified for each batch of product <sup>131</sup>.</p> <p>The main construction contractor <i>or</i> the DBO contractor shall verify claims by obtaining information from supplier(s) of the construction products used. This shall</p>				

<sup>133</sup> "Batch" means a quantity of uniformly labelled product manufactured by the same mixing plant, under the same conditions according to a set mix design with the same input materials.

include mass balance calculations supported by batch testing results, delivery documentation and/or factory production control documentation. In each the data shall be verified by a third party audit.	include mass balance calculations supported by batch testing results, delivery documentation and/or factory production control documentation. In each the data shall be verified by a third party audit.
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Summary rationale:

- The use of materials with high recycled content is one of the practices which has the greatest potential to improve resource efficiency in the construction sector. This practice contributes to sustainable development by diverting materials from landfill and saving natural resources.
- According to the literature, requiring a minimum of 10-15% recycled content by value for the project overall is broadly achievable. The findings of case studies undertaken for a broad range of building types have shown that most buildings have greater than 10% recycled content by value using standard products. Moreover, by using cost-neutral good practice and readily available construction products with higher recycled content, an overall percentage of 15-30% recycled content by value could be obtained.
- On the basis of the collected information, award criteria are proposed on the incorporation of a higher amount of recycled content greater than a minimum of 15% into the main building elements. Evidence suggests that this criterion would have the greatest potential for environmental improvement by focussing on concrete and masonry products, and in particular where they are used in the superstructure and substructure of office buildings as these are significant hot spots. In detail the proposals are as follows:
  - As Core criterion, award points can be proposed in proportion to the incorporation of the recycled content and/or by-products greater than a minimum of 15% by value into the main building elements.
  - As Comprehensive criterion, award points are proposed in proportion to incorporation of the recycled content, re-used content and by-products greater than a minimum of 30% by value into the main building elements.
- To ensure the comparability of bids the criterion should only be used where a concrete and masonry structural solution is to be designed by all bidders. The criterion shall therefore be applicable to office buildings with concrete structural frames, blockwork walls and in-fill and masonry internal and external walls.
- The estimation of the recycled content should be accurately reportable for verification purposes. This shall be on the basis of a production line batch from which deliveries of uniformly labelled or specific product are made to the site. This could be obtained from production management records or batch testing.
- Information on the level of recycled content should be periodically updated to reflect the emerging design and specification, the source and verification method.
- It is recommended to address the potential trade-off from CO<sub>2</sub> emissions associated with the transport of recycled aggregates by combining this criterion with criterion B10.3, which is designed to address transport emissions. The relative weighting of the two criteria should ensure effective competition between potential suppliers whilst also encouraging tenders that deliver an overall environmental benefit.
- If a contracting authority decides to reward recycled or re-used content (see B10.2.) or reduced transport emissions (see B10.3), it should consider setting criteria that take into account the specific conditions in the local market for construction materials. This may need to reflect the local availability of processing plant, and therefore recycled materials, as well as transport infrastructure, with a focus on low carbon bulk transport modes such as rail or shipping.

### **2.3.2.2 At what stage of the procurement process are the criteria relevant?**

First it has to be underlined that, to fully benefit from the use of recycled materials, good practice must be adopted at the earliest possible stage (preliminary scoping and feasibility), and targeted requirements on recycled content should be communicated between the contracting authority and contractor and passed down through the supply chain across all project phases.

The incorporation of the recycled content has been proposed as a Core award criterion and the incorporation of the recycled or reused content as a Comprehensive award criterion. These criteria have to be applied during the detailed design and performance requirements procurement phase. Moreover, recycled content has to be verified during construction of the building or major renovation works procurement phase by means of a contract performance clause.

In detail, during detailed design and performance requirements procurement phase, the *Design team* or the *Design & Build tenderer* or the *DBO tenderer* shall quantify the proportional contribution of the recycled content to the overall value of the building elements and finishing elements. Moreover, the specific building elements and proposed products to be used shall also be specified within the detailed design. The ordering and delivery to site of these building elements shall later be verified during the construction of the building or major renovation works procurement phase by the main *construction contractor* or the *DBO contractor* by providing an independent third party certification of the chain of custody and mass balance for the product and/or recycle or equivalent documentation provided by suppliers and processors.

The criteria classification, their reference numbers in the criteria document and the respective procurement phase can be cross-referenced as follows.

Title of the criterion	Procurement phase	Criterion classification	Criteria typology	Reference number in the criteria document
Incorporation of recycled content	B. Detailed design and performance requirements	Core and Comprehensive	Award criterion	B10.2
Monitoring the recycled content	D. Construction of the building or major renovation works	Core and Comprehensive	Contract performance clauses	D7.

## 2.3.3 Materials transportation

### 2.3.3.1 Background technical aspects, discussion and rationale for CO<sub>2</sub>e emissions from materials transportation

Transportation of large volume virgin, recycled and by-product material such as coarse aggregates was highlighted by stakeholders as a potential environmental hot spot, particularly as there may be trade-offs in the transportation of recycled or by-product materials. Transport of these materials is generally by lorry, which results in fuel-related emissions that are generally greater than or equal to those for the production of such materials. If these materials are moved over distances greater than 25 km<sup>134</sup>, then the resulting emissions can contribute significantly to the environmental impacts of the production phase for the main building elements.

Marinkovic et al (2014)<sup>135</sup> highlights for concrete that whilst aggregate production can account for 0.8% and 5.4% across all impact categories, the variation in transport distances can also be a significant consideration, with the comparable contribution to the Global Warming Potential (GWP) impact category ranging from 3% to 20% depending on the distances. A further interrogation of the data suggests that there may be less potential for variation, but nonetheless still one that is potentially significant. This suggests that if transport distances by lorry were to rise from 25 km to 50km or 200km then the transport contribution to the Global Warming Potential (CO<sub>2</sub>e) of a concrete mix delivered to a construction site could rise, indicatively, from 1.3% to 2.5-10%. As a result, the potential benefits of switching from natural to recycled coarse aggregate could be eclipsed by greater transport emissions. This finding is supported by recent LCA research for the Cement industry<sup>136</sup>.

According to some literature sources, such as Pacheco-Torgal et al (2013)<sup>137</sup>, WRAP (2011)<sup>138</sup> and WRAP (2006)<sup>139</sup>, it might not always be the case that the transport distance, and consequently the costs, of recycled

<sup>134</sup> Blengini G.A. and Garbarino E. (2010). Resources and waste management in Turin (Italy): the role of recycled aggregates in the sustainable supply mix. *Journal of Cleaner Production* 18, 1021–1030

<sup>135</sup> Marinkovic S.B., Malesev M. and Ilgjatovic, *Life Cycle Assessment (LCA) of concrete made using recycled concrete or natural aggregates published in Eco-efficient construction and building materials* (2014), Woodhead Publishing Limited, p.239-266

<sup>136</sup> European Cement Research Academy, *Closing the loop: What type of concrete reuse is the most sustainable option?* 27 November 2015

<sup>137</sup> Pacheco-Torgal F., Tam V. W. Y., Labrincha J.A., Ding Y. and de Brito J. ed (2013). *Handbook of recycled concrete and demolition waste.*, Woodhead Publishing, Number 47, Elsevier .

material, are lower than the ones for natural construction materials, and that other additional factors, such as the embodied carbon and the transport mode, may influence both the costs and the environmental impacts. Large-volume, high-weight construction materials with relatively low embodied carbon, such as natural, recycled or secondary aggregates, can have a disproportionately high contribution to CO<sub>2</sub>e emissions from transport and the mode of transport is therefore a relevant aspect to be considered. With respect to the mode, transport by road can be four times more carbon intensive than rail and thirty seven times more carbon intensive than bulk shipping (WRAP 2011).

Another issue is the availability of treatment plant for the receiving and crushing of construction and demolition waste. This may vary depending on the demand in the local area for crushed recycled aggregate, as well as having the potential to push up prices if longer distance lorry transportation is required <sup>140</sup>. In this case, and in order to avoid trade-offs in the form of higher CO<sub>2</sub> emissions, there would be the need to support lower emission modes of bulk transport such as rail or shipping. Rail infrastructure can, for example, be used to address imbalances between supply and demand across regions <sup>141</sup>.

Materials transportation is already included in the holistic approach adopted within the use of EPDs or an LCA study. If points are not assigned to tenderers by means of using EPDs or by carrying out an LCA, an alternative would be to propose an evaluation of the CO<sub>2</sub>e emission / tonne of material transported. At the most basic level, there are several national or internationally available Green House Gas (GHG) emissions calculators that can be used to this purpose, such as ENCODE Protocol (2013), ICE Demolition Protocol (ICE, 2008), DEFRA's Guidelines for Company Reporting on Greenhouse Gas Emissions<sup>142</sup>, WRAP's CO<sub>2</sub> Estimator Tool<sup>143</sup> and the RICS embodied carbon calculator<sup>144</sup> that could be used to encourage the use of recycled materials and minimise associated haulage movements.

### 2.3.3.2 Final criteria proposal following the written consultation

Core criteria	Comprehensive criteria
AWARD CRITERIA	
<p><b>B10.3 Performance requirements for CO<sub>2</sub>e emissions from the transportation of aggregates</b></p> <p><i>This criterion should not be used where criterion B10.1 is applied. It is recommended to consider combining this criterion with B10.2 in order to achieve an overall environmental benefit. This should always be done based on an understanding of the local market conditions and by establishing and clearly specifying in the ITT a weighting of the two criteria that will ensure effective competition and reward bids that offer the best overall environmental performance.</i></p> <p>Points will be awarded in proportion to the reduction in the CO<sub>2</sub>e emission/tonne of aggregates <sup>145</sup> for use in the production of the main building elements listed in Table (e).</p> <p><i>The method and tool to be used to calculate the CO<sub>2</sub>e emissions from the transportation shall be specified in the ITT. In some Member States there may already be building permitting requirements and associated tools made available for the calculation of transport-related CO<sub>2</sub> equivalent emissions, in which case the bidders shall declare the emissions based on using these rules.</i></p>	<p><b>B10.3 Performance requirements for CO<sub>2</sub>e emissions from the transportation of aggregates</b></p> <p><i>This criterion should not be used where criterion B10.1 is applied. It is recommended to consider combining this criterion with B10.2 in order to achieve an overall environmental benefit. This should always be done based on an understanding of the local market conditions and by establishing and clearly specifying in the ITT a weighting of the two criteria that will ensure effective competition and reward bids that offer the best overall environmental performance.</i></p> <p>Points will be awarded in proportion to the reduction in the CO<sub>2</sub>e emission/tonne of aggregates <sup>135</sup> for use in the production of the main building elements listed in Table (f).</p> <p><i>The method and tool to be used to calculate the CO<sub>2</sub>e emissions from the transportation shall be specified in the ITT. In some Member States there may already be building permitting requirements and associated tools made available for the calculation of transport-related CO<sub>2</sub> equivalent emissions, in which case the bidders shall declare the emissions based on using these rules.</i></p>

<sup>138</sup> WRAP (2011). Cutting embodied carbon in construction projects. Information sheet for construction clients and designers. <http://www.wrap.org.uk/sites/files/wrap/FINAL%20PRO095-009%20Embodied%20Carbon%20Annex.pdf>

<sup>139</sup> WRAP (2006). The sustainable use of resources for the production of aggregates in England. [http://www.sustainableaggregates.com/library/docs/wrap/L0329\\_AGG0059\\_Ciria.pdf](http://www.sustainableaggregates.com/library/docs/wrap/L0329_AGG0059_Ciria.pdf)

<sup>140</sup> ibid 136

<sup>141</sup> Sustainable Aggregates project (2008) *Theme 1 - Reducing the environmental effect of transport aggregate*, UK,

<sup>142</sup> DEFRA <https://www.gov.uk/measuring-and-reporting-environmental-impacts-guidance-for-businesses>

<sup>143</sup> WRAP [http://aggregain.wrap.org.uk/sustainability/try\\_a\\_sustainability\\_tool/co2\\_emissions.html](http://aggregain.wrap.org.uk/sustainability/try_a_sustainability_tool/co2_emissions.html)

<sup>144</sup> Royal Institute of Chartered Surveyors (2014) *Methodology to calculate embodied carbon*, RICS guidance note

<sup>145</sup> Aggregates can encompass: i) natural aggregates (such as sand, gravel, crushed rocks), ii) recycled aggregates (such as materials from Construction & Demolition Waste) and iii) secondary aggregates (such as slag and ashes from industrial processes)

A maximum target for CO<sub>2</sub>e emissions/tonne aggregates transported could be set by the contracting authority based on information from the design team. This, together with their assumptions and rules, shall be included in the ITT for the main contractor.

*Table e. Scope of the building elements to be included*

New-build	Renovation
<ul style="list-style-type: none"> <li>- The structural frame, including beams, columns and slabs</li> <li>- External walls,</li> <li>- Floors and ceilings</li> <li>- Internal walls</li> <li>- Roofs</li> <li>- Foundation and substructure</li> </ul>	<ul style="list-style-type: none"> <li>- External walls, cladding and insulation</li> <li>- Internal walls</li> <li>- Re-roofing</li> </ul> <p>Where additional floors or building extensions are foreseen that account for &gt;25% of the existing useable floor area, the list of new-build elements shall also apply.</p>

**Verification:**

The DB tenderer *or* the DBO tenderer shall provide an estimate of the CO<sub>2</sub>e/tonne for aggregates that are used in the specified building elements using the calculation tool specified in the ITT. The transport mode(s) shall be specified and the emissions factor for each transport mode multiplied by the relevant quantities of materials as stated in the Bill of Quantities.

A maximum target for CO<sub>2</sub>e emissions/tonne aggregates transported could be set by the contracting authority based on information from the design team. This, together with their assumptions and rules, shall be included in the ITT for the main contractor.

*Table f. Scope of the building elements to be included*

New-build	Renovation
<ul style="list-style-type: none"> <li>- The structural frame, including beams, columns and slabs</li> <li>- External walls,</li> <li>- Floors and ceilings</li> <li>- Internal walls</li> <li>- Roofs</li> <li>- Foundation and substructure</li> </ul>	<ul style="list-style-type: none"> <li>- External walls, cladding and insulation</li> <li>- Internal walls</li> <li>- Re-roofing</li> </ul> <p>Where additional floors or building extensions are foreseen that account for &gt;25% of the existing useable floor area, the list of new-build elements shall also apply.</p>

**Verification:**

The DB tenderer *or* the DBO tenderer shall provide an estimate of the CO<sub>2</sub>e/tonne for aggregates that are used in the specified building elements using the calculation tool specified in the ITT. The transport mode(s) shall be specified and the emissions factor for each transport mode multiplied by the relevant quantities of materials as stated in the Bill of Quantities.

*Summary rationale:*

- If aggregates are transported over distances greater than 25 km, the resulting emissions can contribute significantly to the environmental impacts of the production phase for main building elements.
- Transportation of aggregates is one of the main environmental hot-spots for concrete production but can vary depending on transport distances. The contribution to cradle to gate Global Warming Potential (CO<sub>2</sub>e) can indicatively range from 1.3% to 10%.
- The mode of transport is an important consideration. Transport of these materials is typically by lorry, which can be four times more carbon intensive than rail and thirty seven times more carbon intensive than bulk shipping. Minimising transport-related emissions can therefore help to promote the use of lower impact modes of transport such as rail or shipping for these materials.
- Materials transportation is already included in the holistic approach by means of the EPDs or the LCA. If points are not assigned by means of aggregating EPDs or an LCA study, an alternative award criterion is proposed addressing the evaluation of the CO<sub>2</sub>e emissions / tonne of material transported.
- It is recommended to combine this criterion with the criterion on recycled content (B10.2) in order to achieve an overall environmental benefit. This should always be done based on an understanding of the local market conditions (*e.g. local recycling capacity, transport infrastructure*) and by establishing and clearly specifying in the ITT a weighting of the two criteria that will ensure effective competition and reward bids that offer the best overall environmental performance.
- There are several nationally or internationally available GHG calculators that can be used for this purpose.



### 2.3.3.3 At what stage of the procurement process are the criteria relevant?

Firstly, it has to be underlined that early contractor involvement (ECI) could provide opportunities before fixing the building location in the preliminary scoping and feasibility:

The evaluation of the CO<sub>2</sub>e emissions from the transportation of materials for the main building elements has been proposed as an award criterion (both Core and Comprehensive criterion) to be applied during the detailed design and performance requirements procurement phase.

The criteria classification, their reference numbers in the criteria document and the respective procurement phase can be cross-referenced as follows.

Title of the criterion	Procurement phase	Criterion classification	Criteria typology	Reference number in the criteria document
Performance requirements for CO <sub>2</sub> e emission from materials transportation	B. Detailed design and performance requirements	Core and Comprehensive	Award criterion	B10.3

## 2.3.4 Timber

### 2.3.4.1 Responsible sourcing of timber construction materials

#### 2.3.4.1.1 Background technical discussion and rationale

Timber construction materials are renewable raw materials of which the continued availability should be preserved to ensure a sustainable future supply and to protect the important role of forests as biological systems and habitats. The importance of ensuring that the wood and wood-based materials used in the construction and renovation of buildings are sourced from legal and sustainable sources is a policy objective at international and EU level. Moreover, there is significant experience in Member States and within the timber and construction industries in sourcing according to the sustainable forestry criteria of established private certification schemes.

#### *Legally sourced timber*

The Timber Regulation (EC) 995/2010<sup>146</sup> introduced new requirements for the sourcing of timber products from 2013. It prohibits illegally harvested timber from being placed on the EU market and introduces requirements for 'due diligence', which it defines as comprising:

- (a) measures and procedures providing access to the [origin of] the operator's supply of timber or timber products placed on the market;*
- (b) risk assessment procedures enabling the operator to analyse and evaluate the risk of illegally harvested timber or timber products derived from such timber being placed on the market.*
- (c) except where the risk identified in course of the risk assessment procedures referred to in point (b) is negligible, risk mitigation procedures which consist of a set of measures and procedures that are adequate and proportionate to minimise effectively that risk and which may include requiring additional information or documents and/or requiring third party verification.*

The Regulation defines legally harvested as wood and wood-based materials (excluding packaging and recycled wood) that has been '*harvested in accordance with the applicable legislation in the country of harvest*'. "Applicable legislation" means the legislation in force in the country of harvest covering the following matters:

- Rights to harvest timber within legally gazetted boundaries;
- Payments for harvest rights and timber including duties related to timber harvesting;
- Timber harvesting, including environmental and forest legislation including forest management and biodiversity conservation, where directly related to timber harvesting;
- Third parties' legal rights concerning use and tenure that are affected by timber harvesting; and
- Trade and customs, in so far as the forest sector is concerned.

<sup>146</sup> Regulation (EU) No 995/2010 of the European Parliament and of the Council of 20 October 2010 laying down the obligations of operators who place timber and timber products on the market

Valid EU FLEGT and UN CITES licenses are deemed to provide assurance of legality. Europe is in the process of introducing the FLEGT (Forest Law Enforcement Governance and Trade) licensing scheme. FLEGT is based on bilateral agreements between the EU and timber producing countries. Third party forest and forest products certification systems that meet the due diligence criteria set out in Article 6 of the Regulation can be used as a valuable tool in the due diligence system.

Despite the obligations from the Timber Regulation, there is still a risk that timber provided under a public contract may come from non-legal sources. This can pose a major reputational risk for the contracting authority. Public authorities, which wish to have a higher degree of reassurance that the timber is actually legally sourced, can include a selection criterion regarding the technical ability of the tenderer to ensure compliance with the obligations from the EU Timber Regulation, combined with a contract performance clause requiring that the timber supplied under the contract has been legally placed on the market.

### *Sustainably Sourced timber*

Further investigation of the basis for both European sustainable forestry policy<sup>147</sup> and certification schemes for sustainable forestry<sup>148</sup> confirms their basis in the UNEP and FAO principles of Sustainable Forestry Management (SFM) established at the Rio Earth Summit in 1992<sup>149</sup>. These principles, although not defined in specific detail in UNEP or FAO literature, provide an internationally agreed reference point which is used by certification schemes. The conformance of schemes with ISO/IEC 17065 is also a consideration in relation to the quality and assurance provided by the verification systems used<sup>150</sup>.

In terms of market share the two most significant certification schemes are those operated by the Forestry Stewardship Council (FSC)<sup>151</sup> and the Programme for the Endorsement of Forestry Certification (PEFC)<sup>152</sup>. In 2009 these schemes accounted for 9% of global forestry and 26% of industrial timber supplies<sup>153</sup>. PEFC is the most significant scheme, accounting for over two thirds of certified timber on the world market. The majority (over 90%) of certified timber originates from Europe and North America.

Belgium<sup>154</sup>, Denmark, Germany<sup>155</sup>, the UK<sup>156</sup> and the Netherlands<sup>157</sup> are notable for their detailed monitoring and evaluation of forestry certification schemes in support of Green Public Procurement (GPP)<sup>158</sup>. These Member States use their own adapted criteria and processes to determine whether certification schemes provide sufficient assurance. The current consensus of these Member States is that, in general, FSC and PEFC provide sufficient levels of assurance based on their national criteria. Denmark, Germany, the Netherlands and the UK are currently working together to identify the common ground of their respective timber procurement policies.

Whilst the proportion of forestry covered by these certification schemes market is still relatively low they are considered by the FAO and independent research to have played an important role in influencing forestry practices and in raising awareness of the threat to global forests<sup>159</sup>. However, it has also been highlighted by the UNEP, the FAO and by European Commission policy that in countries where there is poor governance and limited enforcement of forestry protection compliance with these schemes can be challenging<sup>160</sup>.

Although certified sustainable wood is widely available, supply chain development may be required to build relationships with alternative suppliers in some countries. Anecdotal evidence from the construction industry

<sup>147</sup> European Commission, *EU forests and forest related products*, [http://ec.europa.eu/environment/forests/home\\_en.htm](http://ec.europa.eu/environment/forests/home_en.htm)

<sup>148</sup> Rametsteiner, E and M, Simula, *Forest certification—an instrument to promote sustainable forest management?* Journal of Environmental Management 67 (2003) 87–98

<sup>149</sup> Castaneda, F. *Criteria and indicators for sustainable forestry management*. UN FAO, <http://www.fao.org/docrep/x8080e/x8080e06.htm#TopOfPage>

<sup>150</sup> ISO/IEC 17065: 2012, Conformity assessment – requirements for bodies certifying products, processes or services.

<sup>151</sup> Programme for the Endorsement of Forestry Certification, <http://www.pefc.org/>

<sup>152</sup> Forestry Stewardship Council, <http://www.fsc.org/>

<sup>153</sup> UNECE and FAO (2010) *Forest products annual market review 2009–2010*

<sup>154</sup> UK Central Point of Expertise on Timber, *Government procurement of timber in Belgium*, <http://www.cpet.org.uk/uk-government-timber-procurement-policy/international-context/international-policies-1/belgium>

<sup>155</sup> Germany Government Procurement Policy, *Wood and paper based products*, [http://www.sustainableforestprods.org/tools/german\\_government\\_procurement\\_policy](http://www.sustainableforestprods.org/tools/german_government_procurement_policy)

<sup>156</sup> UK Central Point of Expertise on Timber (2008) *Review of forestry certification schemes results*,

<sup>157</sup> Timber Procurement Assessment Committee, Netherlands, <http://www.tpac.smk.nl/>

<sup>158</sup> UK Central Point of Expertise on Timber (2008) *A comparative study of the national criteria for 'legal and 'sustainable' timber and assessment of certification schemes in Denmark, UK, Netherlands and Belgium* <http://www.cpet.org.uk/uk-government-timber-procurement-policy/international-context/international-policies-1/comparative-study-of-danish-uk-dutch-and-belgium-national-criteria>

<sup>159</sup> UNECE and FAO (2010) *Forest products annual market review 2009–2010* see also Rametsteiner, E and M, Simula, *Forest certification—an instrument to promote sustainable forest management?* Journal of Environmental Management 67 (2003) 87–98

<sup>160</sup> UNECE, FAO and UNFF (2009) *Vital forest graphics*

in Member States such as the UK and Germany does, however, suggest that there are no general difficulties in obtaining supplies on major projects.

Sustainable certified wood may carry a modest price premium due to both the added cost of wood producers needing to pay for independent audits and the general willingness for customers to pay a premium for final products made with certified sustainable wood. A report by CBI Ministry of Foreign Affairs stated that a general price premium of 10-30% existed for FSC-certified wood imported to the Netherlands<sup>161</sup>. However, in general there is no clear evidence as to whether or not certified sustainable wood is more expensive than non-certified wood across the EU.

Although 100% certified sustainable wood is desirable, it could be difficult to achieve due to possible fluctuations in market demand, particularly for SMEs that are accustomed to working with a limited number of suppliers. Instead, it is considered more appropriate to require a minimum of 25% sustainable wood should be easily achievable while more ambitious public authorities could set a minimum requirement of 70%, with a recommendation to seek feedback from the market prior to publishing the ITT.

As mentioned above, several Member States use their own criteria to define sustainable management of forests and have different processes in place to determine whether certification schemes provide sufficient assurance. Work between leading Member States is under way to identify common ground. In this situation, it was not possible, within the framework of this criteria development process, to provide a harmonised definition of sustainable managed forestry. Once the work of the above-mentioned Member States is finalised, the Commission will evaluate the results and decide on possible steps to be taken.

#### 2.3.4.1.2 Summary of feedback from the stakeholder written consultation

##### **Stakeholder feedback received during the final written consultation**

With regards to the legality of timber, a stakeholder highlighted that the EUTR is in place but the obligations of due diligence are for Operators. It was therefore considered that a specifier of timber (i.e. a construction contractor) does not need to ask for specific evidence of due diligence for the timber they are specifying, i.e. they do not need to know the sources. As a result, it was considered that all they should be asking for is evidence that an operator has a due diligence system in place.

A stakeholder commented that a requirement for the responsible sourcing of materials should apply to any material being used, and not be confined to wood only. They made reference to a standard on 'responsible sourcing' in the UK. If wood would be the only construction material for which responsible sourcing must be documented, then points could be awarded for that, but otherwise the same responsible sourcing should be requested for other construction materials, since they may originate from unsustainable production processes with high environmental impacts.

*These comments are addressed in the above-given background discussion and rationale.*

#### 2.3.4.1.3 Final criteria proposal

Core criteria	Comprehensive criteria
SELECTION CRITERIA	
<b>D1. Sourcing of legal timber by the lead construction contractor</b>  All timber or timber products <sup>162</sup> to be supplied under the contract must be legally harvested in accordance with Regulation (EU) 995/2010 (the 'EU Timber Regulation').  <i>This technical specification should be combined with the contract performance clause under D7.</i>  <b>Verification:</b>  At the latest by the time of the award of the contract, the lead contractor shall provide information on:  - The operators or the traders (as defined in Regulation	<b>D1. Sourcing of legal timber by the lead construction contractor</b>  All timber or timber products <sup>152</sup> to be supplied under the contract must be legally harvested in accordance with Regulation (EU) 995/2010 (the 'EU Timber Regulation').  <i>This technical specification should be combined with the contract performance clause under D7.</i>  <b>Verification:</b>  At the latest by the time of the award of the contract, the lead contractor shall provide information on:  - The operators or the traders (as defined in Regulation

<sup>161</sup> CBI report, accessed online at: [http://www.cbi.eu/system/files/marketintel/FSC-certified\\_tropical\\_timber\\_garden\\_furniture\\_in\\_The\\_Netherlands.pdf](http://www.cbi.eu/system/files/marketintel/FSC-certified_tropical_timber_garden_furniture_in_The_Netherlands.pdf)

<sup>162</sup> for timber and timber products within the remit of EU Timber Regulation

<p>(EU) 995/2010) who will supply the timber and timber products used in the construction of the building;</p> <ul style="list-style-type: none"> <li>- Evidence of the risk assessment and mitigation procedures put in place by the operator(s) first placing on the EU market the timber and timber products to be used in the construction of the building, in accordance with Article 6(1) (b) and (c) of Regulation (EU) 995 of 2010 as well as, where applicable, of the means whereby traders further down the supply chain ensure traceability, in accordance with Article 5 of Regulation (EU) 995 of 2010.</li> </ul>	<p>(EU) 995/2010) who will supply the timber and timber products used in the construction of the building;</p> <ul style="list-style-type: none"> <li>- Evidence of the risk assessment and mitigation procedures put in place by the operator(s) first placing on the EU market the timber and timber products to be used in the construction of the building, in accordance with Article 6(1) (b) and (c) of Regulation (EU) 995 of 2010 as well as, where applicable, of the means whereby traders further down the supply chain ensure traceability, in accordance with Article 5 of Regulation (EU) 995 of 2010.</li> </ul>
<b>CONTRACT PERFORMANCE CLAUSE</b>	
<p><b>D7. Sourcing of legal timber</b></p> <p>The contracting authority is entitled to carry out spot checks regarding compliance with Technical Specification D1 for all or a specified sub-set of the timber products used under the contract. Upon request, the contractor should provide evidence to demonstrate compliance with the EU Timber Regulation:</p> <p>In most cases – where the contractor is not the company first placing timber or timber products on the EU market but obtains such products from others (defined as a ‘trader’<sup>163</sup> in Regulation 995/2010), the contractor should provide the following information in respect of timber or timber products to be verified during the spot check:</p> <ul style="list-style-type: none"> <li>- The operators or the traders who have supplied the timber and timber products used in construction of the building;</li> <li>- Documents or other information indicating compliance of those timber products with the applicable legislation;</li> <li>- Evidence of the risk assessment and mitigation procedures put in place in accordance with Article 6(1) (b) and (c) of Regulation (EU) 995 of 2010.</li> </ul> <p>In cases where the contractor places timber or timber products for the first time on the EU market for use in the construction project (defined as an ‘operator’<sup>164</sup> in Regulation 995/2010), the contractor should provide the following information in respect of timber or timber products covered by the spot check:</p> <ul style="list-style-type: none"> <li>- A description of each type of timber used, including the trade name, type of product, the common name of tree species and, where applicable, its full scientific name;</li> <li>- Name and address of the supplier of the timber and timber products;</li> <li>- The country of harvest, and where applicable<sup>165</sup>: <ul style="list-style-type: none"> <li>(i) Sub-national region where the timber was harvested;</li> <li>(ii) Concession of harvest;</li> <li>(iii) Quantity (expressed in volume, weight or number of units);</li> </ul> </li> </ul>	<p><b>D7. Sourcing of legal timber</b></p> <p>The contracting authority is entitled to carry out spot checks regarding compliance with Technical Specification D1 for all or a specified sub-set of the timber products used under the contract. Upon request, the contractor should provide evidence to demonstrate compliance with the EU Timber Regulation:</p> <p>In most cases – where the contractor is not the company first placing timber or timber products on the EU market but obtains such products from others (defined as a ‘trader’<sup>156</sup> in Regulation 995/2010), the contractor should provide the following information in respect of timber or timber products to be verified during the spot check:</p> <ul style="list-style-type: none"> <li>- The operators or the traders who have supplied the timber and timber products used in construction of the building;</li> <li>- Documents or other information indicating compliance of those timber products with the applicable legislation;</li> <li>- Evidence of the risk assessment and mitigation procedures put in place in accordance with Article 6(1) (b) and (c) of Regulation (EU) 995 of 2010.</li> </ul> <p>In cases where the contractor places timber or timber products for the first time on the EU market for use in the construction project (defined as an ‘operator’<sup>156</sup> in Regulation 995/2010), the contractor should provide the following information in respect of timber or timber products covered by the spot check:</p> <ul style="list-style-type: none"> <li>- A description of each type of timber used, including the trade name, type of product, the common name of tree species and, where applicable, its full scientific name;</li> <li>- Name and address of the supplier of the timber and timber products;</li> <li>- The country of harvest, and where applicable<sup>157</sup>: <ul style="list-style-type: none"> <li>(i) Sub-national region where the timber was harvested;</li> <li>(ii) Concession of harvest;</li> <li>(iii) Quantity (expressed in volume, weight or number of units);</li> </ul> </li> </ul>

<sup>163</sup> ‘trader’ means any natural or legal person who, in the course of a commercial activity, sells or buys on the internal market timber or timber products already placed on the internal market

<sup>164</sup> ‘operator’ means any natural or legal person that places timber or timber products on the market;

<sup>165</sup> for more information, see: <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012R0607&from=>

<ul style="list-style-type: none"> <li>- Documents or other information indicating compliance of those timber products with the applicable legislation;</li> <li>- Evidence of the risk assessment and mitigation procedures put in place in accordance with Article 6(1) (b) and (c) of Regulation (EU) 995 of 2010. This may include certification or other third party verified schemes.</li> </ul> <p>Timber covered by valid EU FLEGT or CITES licenses shall be considered to have been legally harvested according to Regulation (EU) No 995/2010.</p>	<ul style="list-style-type: none"> <li>- Documents or other information indicating compliance of those timber products with the applicable legislation;</li> <li>- Evidence of the risk assessment and mitigation procedures put in place in accordance with Article 6(1) (b) and (c) of Regulation (EU) 995 of 2010. This may include certification or other third party verified schemes.</li> </ul> <p>Timber covered by valid EU FLEGT or CITES licenses shall be considered to have been legally harvested according to Regulation (EU) No 995/2010.</p>
<p><b>Background note: Sustainable Sourcing of Timber</b></p> <p><i>These GPP criteria do not include a proposal on the sourcing of timber from sustainable forestry, for the following reasons:</i></p> <p>Several Member States are using their own GPP/SPP criteria to define sustainable management of forests and have different processes in place to determine whether certification schemes provide sufficient assurance. In this situation, it was not possible, within the framework of this criteria development process, to provide a harmonised definition of sustainable managed forestry.</p> <p>The current consensus of the above-mentioned Member States is that, in general, FSC and PEFC provide sufficient levels of assurance for compliance with their national criteria. Although 100% certified sustainable wood is desirable, it could be difficult to achieve due to possible fluctuations in market demand, particularly for SMEs that are accustomed to working with a limited number of suppliers. Instead, a minimum of 25% sustainable wood should be easily achievable while more ambitious public authorities could set a minimum requirement of 70%, with a recommendation to seek feedback from the market prior to publishing the ITT.</p>	

*Note to contracting authorities on the legal sourcing of timber:*

Suitable remedies should be provided under the contract for cases of non-compliance with the above clause. Advice on the application of these requirements, and the monitoring organisations able to verify compliance, may be obtained from the competent national authorities listed at:  
[http://ec.europa.eu/environment/forests/pdf/list\\_competent\\_authorities\\_eutr.pdf](http://ec.europa.eu/environment/forests/pdf/list_competent_authorities_eutr.pdf)

**Summary of the rationale:**

- The high profile of public construction projects suggests that it is important that the origin of timber used for construction is legal, in compliance with the existing obligations set under the EUTR, and sustainable. Moreover, the origin and legality shall be traceable and verifiable to provide a high level of assurance.
- In order to ensure compliance with the EUTR, it is required that for all Office Building projects contractors shall provide documentary evidence of due diligence to verify legal sourcing or traceability along the supply chain, with the information requested depending if the contractors are 'operators' or 'traders' as defined by the EUTR. Moreover, in GPP, the requirement for due diligence shall be extended to the 'specifier' of the timber in order to promote a higher level of supply chain assurance in construction contracts.
- Both a specific Selection criterion and a Contract Performance Clause are proposed in order to provide contracting authorities with additional assurance and risk management that timber is sourced legally.
- For the moment, in view of the differences in national approaches to sustainable timber procurement and the on-going work aiming at identifying the communalities between different schemes, no definitions or proposed criterion addressing the sustainability of timber is proposed within this criteria set.

### 2.3.4.2 At what stage of the procurement process are the criteria relevant?

It is important that tenderers for the construction contract for construction of the building and major renovation works identify where wood is to be used in the building, the type and quantity of wood and how the legality of the wood will be ensured. This will ensure that tenderers that have developed their supply chain for responsibly sourced wood are encouraged to bid.

As construction proceeds, it is then important that the main construction contractor collates evidence that the wood brought onto site is responsibly sourced, as this has been a point of weakness in some high profile public building contracts. The contractor shall submit independently certified chain of custody certificates for wood purchases demonstrating that it is sustainably sourced. The criteria classification, their reference numbers in the criteria document and the respective procurement phase can be cross-referenced as follows.

Title of the criterion	Procurement phase	Criterion classification	Criteria typology	Reference number in the criteria document
Legal sourcing of timber by the lead construction contractor	D. Construction of the building or major renovation works	Core and Comprehensive	Selection	D2.
Legal sourcing of timber	D. Construction of the building or major renovation works	Core and Comprehensive	Contract Performance Clause	D3.

### 2.3.5 Waste management plan

Raw materials for the building sector are extracted, processed, transported, used in the construction phase and finally disposed. All these stages imply a range of environmental impacts, which are significant due to the substantial amount of materials involved. Moreover, the environmental impacts of the end-of-life phase due to the landfilling of construction and demolition waste (C&DW) derive from the large use of land and the lifetime of the landfill.

Although LCA studies on office buildings across Europe show that the influence of the end-of-life phase cannot be considered as significant from a life cycle perspective, the relative importance of different scenarios was investigated in the JRC IPTS draft preliminary report<sup>166</sup>. In one scenario 100% of the waste was landfilled, while in another high recycling rates were considered, with a recycling potential up to 90% for materials as concrete, bricks and steel (representing the 83% of the total weight of the building) and a 95% rate of efficiency for recycling processes.

The difference in the overall environmental impacts between the two above mentioned scenarios was around 2%, taking into consideration the whole life cycle of the building. However, keeping in mind the continued reduction of energy consumption by new buildings, other life cycle phases such as construction resource efficiency will gain more importance and therefore, the relative importance of recycling and re-use is expected to be greater in future. A recent assessment of scenarios and options for resource efficiency for the European Resource Efficiency Platform of the Commission<sup>167</sup> highlighted the importance of:

- Recycling concrete instead of landfilling,
- The use of recycled construction and demolition waste, and
- A reduction in the amount of waste from construction.

It has to be considered that the characteristics of waste produced during the construction phase is significantly different compared to the waste produced during the demolition (end of life) phase. At the demolition phase, which can comprise both the demolition of existing buildings that may be on site and the End-of-Life demolition of the new building, significant amounts of mixed waste, including C&DW and dismantled equipment, are produced through standard demolition practices. Segregated streams of waste can be produced by means of more sophisticated and costly selective demolition practices, which should be planned from the initial design phase. During the construction phase, the waste streams are easily segregated and consist mainly of separated streams of concrete, metals, gypsum, timber, packaging, paints.

<sup>166</sup> JRC IPTS Draft Preliminary Study (2011): <http://susproc.jrc.ec.europa.eu/buildings/docs/Draft%20Report%20Task%203.pdf>

<sup>167</sup> European Commission (2014) *Assessment of scenarios and options towards a resource efficient Europe: An analysis for the European built environment*.

These waste management and reuse, recycling and recovery activities differ notably depending on the type of waste to be dealt with and may be carried out by different contractors. It therefore appears advisable to differentiate the GPP criteria between site waste management during the construction phase, and demolition waste management prior to commencement on site and at the end of the building life. Different scenarios have to be taken into consideration for the development of the GPP criteria in this area:

- the total or partial demolition of an existing building, aimed in the first case at creating a site for a new building and in the second case the renovation of an existing building. In these cases, the management of demolition waste has to be planned at an early stage including project-specific targets for total waste arisings to be checked during a pre-demolition/strip-out audit;
- the construction phase during which waste produced should be managed by means of planning, monitoring and implementing measures
- the total or partial demolition of the constructed building at the end of its lifetime. This scenario could be similar to the first one, but in a different time frame.

With reference to a possible chronological sequence of practices, firstly a criterion would address demolition waste management (to be applied both to the demolition of an existing building and the future demolition of the constructed building) followed by a criterion addressing site waste management. This criterion shall specifically apply to:

- Parts of an existing building which are to be renovated (short term)
- Existing buildings which need to be demolished to clear a site before construction can start on the new building (short term)
- The end of life stage of the office building under consideration (long term)

### **2.3.5.1 Demolition waste audit and management plan**

#### *2.3.5.1.1 Background technical discussion and rationale*

The importance of waste management is reflected in the development of the Waste Framework Directive<sup>168</sup>. Article 11.2 is of particular relevance to the building sector, stating that:

*(b) by 2020, the preparing for re-use, recycling and other material recovery, including backfilling operations using waste to substitute other materials, of non-hazardous construction and demolition waste (C&DW) excluding naturally occurring material defined in category 17 05 04 in the list of waste shall be increased to a minimum of 70 % by weight.*

C&DW has been identified as a priority waste stream by the European Union because there is a high potential for recycling and re-use of this waste type. The potential is assessed to be large due to the existing level of recycling and re-use of C&DW, which varies greatly (between less than 10% and over 90%) in the Member States (PE EC DG-ENV, 2013)<sup>169</sup>. BIOIS, EC (2011) has reported an average recycling percentage of 46% across the EU<sup>170</sup>.

According to WRAP's Guidance on procurement requirements for reducing waste and using resources efficiently<sup>171</sup>, it is recommended that a Demolition Waste Management Plan is developed from an early stage including project-specific targets for total waste arisings and the amount of waste sent to landfill. The purpose of the waste management plan is to ensure, firstly, a reduction of the C&DW generation and, secondly, a suitable treatment of the unavoidable C&DW generated to ensure that it causes the lowest environmental impact. Deconstruction at the end of the building's life may often be a limited opportunity if the building/infrastructure was not designed for deconstruction<sup>172</sup>.

<sup>168</sup> Waste Framework Directive (WFD) 2008/98/EC: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:312:0003:0030:en:PDF>

<sup>169</sup> PE EC DG-ENV (2013). Assessment of Scenarios and Options towards a Resource Efficient Europe. Topical Paper 4: Validation of technical improvement options for resource efficiency of buildings and infrastructure: [http://ec.europa.eu/environment/enveco/resource\\_efficiency/pdf/TP4.pdf](http://ec.europa.eu/environment/enveco/resource_efficiency/pdf/TP4.pdf)

<sup>170</sup> BIOIS, EC (2011). Service Contract on Management of Construction and Demolition Waste – SR1. Final Report Task 2: [http://ec.europa.eu/environment/waste/pdf/2011\\_CDW\\_Report.pdf](http://ec.europa.eu/environment/waste/pdf/2011_CDW_Report.pdf)

<sup>171</sup> WRAP Guidance Procurement requirements for reducing waste and using resources efficiently: [http://www.wrap.org.uk/sites/files/wrap/WRAP%20Construction%20Guide%20\\_FINAL.pdf](http://www.wrap.org.uk/sites/files/wrap/WRAP%20Construction%20Guide%20_FINAL.pdf)

<sup>172</sup> ICE Demolition Protocol (2008): <http://www.ice.org.uk/getattachment/eb09d18a-cb12-4a27-a54a-651ec31705f1/Demolition-Protocol-2008.aspx>

According to both the scientific literature and experience from Member States, a pre-demolition/strip-out audit allows for identification of the key building and infrastructure materials, which will arise from demolition and excavation works. The typical information provided by the audit comprises:

- Identification and risk assessment of hazardous waste that may require specialist handling and treatment, or emissions that may arise during demolition;
- A Demolition Bill of Quantities with a breakdown of different building materials and products,
- An estimate of the % re-use and recycling potential based on proposals for systems of separate collection during the demolition process,
- An estimation of the % potential for other forms of recovery from the demolition process,

In addition, reclamation of fit-out items, systems and servicing equipment from the building could imply an income or at least cost-neutral opportunity.

A review of fifteen published studies by Mália et al (2013) determined that the average composition of C&DW waste consists mainly of concrete, ceramic and timber materials <sup>173</sup>. For a new-build re-inforced concrete framed building an estimate is made of waste arisings from demolition of between 742 and 1637 kg m<sup>-2</sup>. For a new-build non-residential building there is an estimated range of waste arisings from the demolition of a concrete framed building of between 742 and 1637 kg m<sup>-2</sup> and for a masonry building of between 664 and 825 kg m<sup>-2</sup>. Based on a review of eleven published studies of non-residential refurbishment a range was determined of between 20 and 326 kg m<sup>-2</sup>.

Excavation and backfilling operations are not to be taken into consideration in the best practices described within the EC EMAS Reference Document on Best Environmental Management Practice in the building and construction sector<sup>174</sup>. This is supported by ENCORD's construction waste measurement protocol which recommends recording separately construction, demolition and excavation waste arisings <sup>175</sup>. Excluding excavation and backfilling from the data provided in several references including BIOIS, EC 2011<sup>176</sup>, WRAP Guidance Procurement requirements for reducing waste and using resources efficiently<sup>177</sup> and the ICE Demolition Protocol<sup>178</sup>, the following non-hazardous waste generated during demolition and strip-out works are suggested to be prepared for re-use, recycling and other forms of material recovery:

- Timber, glass, metal, brick, stone, ceramic and concrete materials recovered from the main building structures;
- Fit-out and non-structural elements, to include doors and their frames, flooring, ceiling tiles, gypsum panels, plastic profiles, insulation materials window frames, window glass, bricks, concrete in the form of blocks and precast elements, steel rebars.

According to WRAP's Guidance and the ICE Demolition Protocol<sup>179</sup>, a specific target of at least 80% of demolition, strip-out and excavation materials to be reused, recycled and recovered can be determined. This reflects a higher band of best practice in some Member States as identified by BIOIS, EC (2011). ENCODE, whose members include a range of EU construction companies, propose 'diversion rates' of 80% for segregated waste sent off site, 100% for segregated waste which is classified as end-of-waste under the Waste Framework Directive and 50% for inert soil and stones that will be put to beneficial use (e.g. backfilling and restoration) <sup>175</sup>.

Because of the proposed exclusion of excavation waste and backfilling in order to avoid downcycling and to stimulate further improvements in the resource efficiency of the construction sector, a reduction of the specific target to a minimum of 55% by weight can be proposed as Core GPP criterion, reflecting the lower end band of best practice identified by BIOIS, EC (2011). The specific target of at least 80% by weight could

<sup>173</sup> Mália.M, de Brito.J, Pinheiro.M.D and M.Bravo, *Construction and demolition waste indicators*, Waste Management & Research, 31(3) p-241-255

<sup>174</sup> EC Reference Document on Best Environmental Management Practice in the building and construction sector (2012): <http://susproc.jrc.ec.europa.eu/activities/emas/documents/ConstructionSector.pdf>

<sup>175</sup> ENCORD, *Construction waste measurement protocol*, Version 1.0, May 2013

<sup>176</sup> BIOIS, EC (2011). Service Contract on Management of Construction and Demolition Waste – SR1. Final Report Task 2. Available online at [http://ec.europa.eu/environment/waste/pdf/2011\\_CDW\\_Report.pdf](http://ec.europa.eu/environment/waste/pdf/2011_CDW_Report.pdf)

<sup>177</sup> WRAP Guidance Procurement requirements for reducing waste and using resources efficiently:

[http://www.wrap.org.uk/sites/files/wrap/WRAP%20Construction%20Guide%20\\_FINAL.pdf](http://www.wrap.org.uk/sites/files/wrap/WRAP%20Construction%20Guide%20_FINAL.pdf)

<sup>178</sup> ICE Demolition Protocol (2008): <http://www.ice.org.uk/getattachment/eb09d18a-cb12-4a27-a54a-651ec31705f1/Demolition-Protocol-2008.aspx>

<sup>179</sup> ICE Demolition Protocol (2008): <http://www.ice.org.uk/getattachment/eb09d18a-cb12-4a27-a54a-651ec31705f1/Demolition-Protocol-2008.aspx>



still be proposed as a Comprehensive GPP criterion, but potentially only for use in those Member States where this represents best practice and for materials to be prepared for re-use and recycling rather than recovery, in order to stimulate innovations in line with the WFD hierarchy<sup>180</sup>.

### 2.3.5.1.2 Final criteria proposal

Core criteria	Comprehensive criteria
TECHNICAL SPECIFICATIONS	
<p><b>C1. Demolition waste audit and management plan</b></p> <p>A minimum of 55% by weight of the non-hazardous waste generated during demolition and strip-out works, and excluding excavations and backfilling, shall be prepared for re-use, recycling and other forms of material recovery. This shall include:</p> <ul style="list-style-type: none"> <li>(i) Timber, glass, metal, brick, stone, ceramic and concrete materials recovered from the main building structures;</li> <li>(ii) Fit-out and non-structural elements, to include doors and their frames, flooring, ceiling tiles, gypsum panels, plastic profiles, insulation materials window frames, window glass, bricks, concrete in the form of blocks and precast elements, steel rebars.</li> </ul> <p>The contractor shall carry out a pre-demolition/strip-out audit in order to determine what can be re-used, recycled or recovered. This shall comprise:</p> <ul style="list-style-type: none"> <li>(i) Identification and risk assessment of hazardous waste (including WEEE) that may require specialist handling and treatment, or emissions that may arise during demolition;</li> <li>(ii) A bill of quantities with a breakdown of different building materials and products,</li> <li>(iii) An estimate of the % re-use and recycling potential based on proposals for systems of separate collection during the demolition process,</li> </ul> <p>The materials, products and elements identified shall be itemised in a Demolition Bill of Quantities.</p> <p><b>Verification:</b></p> <p>The lead construction contractor, Design &amp; Build contractor or DBO contractor shall submit a pre-demolition/strip-out audit that contains the specified information.</p> <p>A system shall be used to monitor and account for waste arisings. The destination of consignments of waste and end-of-waste materials shall be tracked using consignment notes and invoices. Monitoring data shall be provided to the contracting authority.</p>	<p><b>C1. Demolition waste audit and management plan</b></p> <p>A minimum of 80% by weight of the non-hazardous waste generated during demolition and strip-out works, and excluding excavations and backfilling, shall be prepared for re-use, recycling. This shall include:</p> <ul style="list-style-type: none"> <li>(i) Timber, glass, metal, brick, ceramics and concrete materials recovered from the main building structures,</li> <li>(ii) Fit-out and non-structural elements, to include doors and their frames, flooring, ceiling tiles, gypsum panels, plastic profiles, insulation materials window frames, window glass, bricks, concrete in the form of blocks and precast elements, steel rebars.</li> </ul> <p>The contractor shall carry out a pre-demolition/strip-out audit in order to determine what can be re-used, recycled. This shall comprise:</p> <ul style="list-style-type: none"> <li>(i) Identification and risk assessment of hazardous waste (including WEEE) that may require specialist handling or treatment, or emissions that may arise during demolition;</li> <li>(ii) A bill of quantities with a breakdown of the different constituent building materials and products,</li> <li>(iii) An estimate of the % re-use and recycling potential based on proposals for systems of separate collection during the demolition process,</li> </ul> <p>The materials, products and elements identified shall be itemised in a Demolition Bill of Quantities.</p> <p><b>Verification:</b></p> <p>The lead construction contractor, Design &amp; Build contractor or DBO contractor shall submit a pre-demolition/strip-out audit that contains the specified information.</p> <p>A system shall be used to monitor and account for waste arisings. The destination of consignments of waste and end-of-waste materials shall be tracked using consignment notes and invoices. Monitoring data shall be provided to the contracting authority.</p>

### Summary rationale:

- The importance of waste management is reflected in the development of the Waste Framework Directive, in which C&DW has been identified as a priority waste stream because there is a high potential for recycling and re-use of this waste type. An average recycling percentage of 46% of

<sup>180</sup> Waste Framework Directive (WFD) 2008/98/EC: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:312:0003:0030:en:PDF>

recycling and re-use of C&DW across the EU could be reported (with a great variation among the Member States, between less than 10% and over 90%). Two distinct bands of best practice can be identified, dependent on the development of infrastructure to support better waste management.

- A Demolition Waste Management Plan can be developed from an early stage including project-specific targets for total waste arisings and the amount of waste sent to landfill. Moreover, a pre-demolition/strip-out audit allows identifying the key building and infrastructure materials, which will arise from demolition and excavation works. The typical information provided are the identification and risk assessment of hazardous waste, a demolition bill of quantities with a breakdown of different building materials and products, an estimation of the % re-use and recycling potential from the demolition process.
- In literature, a target of at least 80% of demolition, strip-out and excavation materials to be reused, recycled and recovered have been identified.
- Backfilling operations cannot be taken into consideration as best practices in the building and construction sector.
- Other non-hazardous demolition waste such as timber, glass, metal, brick, stone, ceramic and concrete materials and fit-out and non-structural elements has to be considered for setting specific benchmarks on re-use, recycling or other form of recovery. In detail, considering the above mentioned materials, the following benchmarks are proposed:
  - o a minimum of 55% by weight as technical specification for the Core criteria;
  - o a minimum of 80% by weight as technical specification for the Comprehensive criteria. In this case, it is recommended to not consider recovery activities, in order to stimulate innovations in line with the WFD hierarchy.

## 2.3.5.2 Site waste management plan

### 2.3.5.2.1 Background technical discussion and rationale

According to Osmani et al., 2008<sup>181</sup>, on average 33 % of waste generation from a construction site is the responsibility of a failure to implement waste prevention measures during both the design and preliminary construction phases. Reporting on findings from a survey of projects in the Netherlands, Bossink and Brouwers (1996) reported that on average 9% by weight of purchased construction materials leaves a site as waste<sup>182</sup>. Significant contributors by weight included stone cladding (29%), piles (17%), concrete (13%), mortar (8%), packaging (7%) and bricks (3%). Additional causal factors highlighted included ordering errors during procurement, damage during materials handling and on-site operational practices.

A review of twenty-three published studies by Mália et al (2013) determined that for a new-build re-inforced concrete framed non-residential building the site waste arisings could be within a range of 48 and 135 kg m<sup>-2</sup>. Concrete and brick generally accounted for approximately 70% of the overall waste volume generated. For all the types of non-residential building structure sampled there was a range of 12 to 135 kg m<sup>-2</sup> with a median of approximately 50 kg m<sup>-2</sup><sup>173</sup>.

A site waste management plan (SWMP) is a commonly cited and widely practiced approach used in the construction industry to plan, monitor and implement actions to manage waste during construction. Such a plan is prepared prior to the commencement of work on-site. A site waste management plan usually consists of:

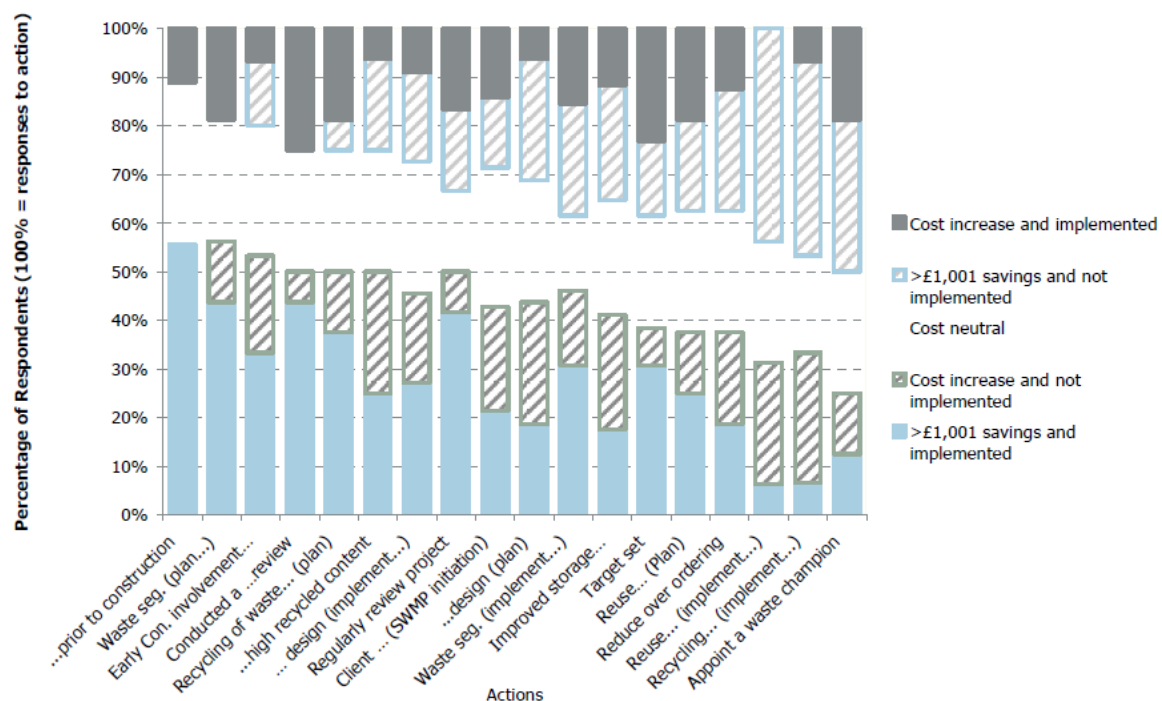
- A bill of materials ordered with estimates for waste arisings based on good practices, and the potential for waste prevention based on good practice,
- Estimates of the % re-use potential based on the use of segregated collection systems during the construction process,
- An estimation of the % recycling and recovery potential based on the use of segregated collection systems.

<sup>181</sup> Osmani, M., Glass, J., Price, A.D.F., 2008. Architects' perspectives on construction waste reduction by design. *Waste Management* 28, 1147-1158

<sup>182</sup> Bossink, B.A.G and H.J.H. Brouwers, *Construction waste: Quantification and source evaluation*, Journal of Construction Engineering and Management, March 1996

The UK provides access to extensive data and feedback from the implementation of SWMP's, having supported a number of best practice initiatives and enacted a legislative requirement between 2008 and 2013. In UK organisation WRAP's Site Waste Management Plans impacts survey 2009<sup>183</sup>, the results are presented of a stakeholders consultation on site waste management plans sent to over 800 contractors and clients in UK. The survey aim was to identify the environmental and economic costs and benefits generated by using a SWMP to implement good practice. It has been highlighted that, if a SWMP is used properly, there can be significant benefits in terms of economic savings and project planning. The top actions identified in the SWMP were the prevention of waste through better design, waste segregation, recycling of waste produced and re-use of materials on site. Figure 2.16 provides an indication of how actions were implemented by 19 completed projects considered within the survey.

In detail, Figure 2.16 shows if these actions have achieved significant cost reductions, were cost-neutral or have resulted in cost increases. This Figure shows the percentage of projects that implemented (full colour) or did not implement actions (diagonal line) and how the SWMP affected the costs (blue: reduce, grey: increase). Starting the SWMP prior to construction, waste segregation at the planning stage and early contractor involvement were the top three actions that were implemented by cost saving projects and not implemented by increased cost projects. This would suggest that these actions, if implemented, are likely to help to reduce costs.



Source: WRAP (2009)

**Figure 2.16. Elements of good practice (based on 19 completed projects)**

In the EC EMAS Reference Document on Best Environmental Management Practice in the building and construction sector<sup>184</sup>, waste generation at 603 construction sites between 2004 and 2010 for different building types is reference from the UK Construction Resources and Waste Platform, 2009<sup>185</sup>. As reported in Figure 2.17, average values are around 15 – 20 m<sup>3</sup> of waste per 100 m<sup>2</sup> (around 10 – 15 t/100 m<sup>2</sup>). Figure 2.18 shows different waste typologies for different types of buildings. As observed, there are four main fractions of waste: bricks, concrete, mixed waste and inert fraction. The rest is composed of timber, packaging waste, metals and other minor quantities of other materials.

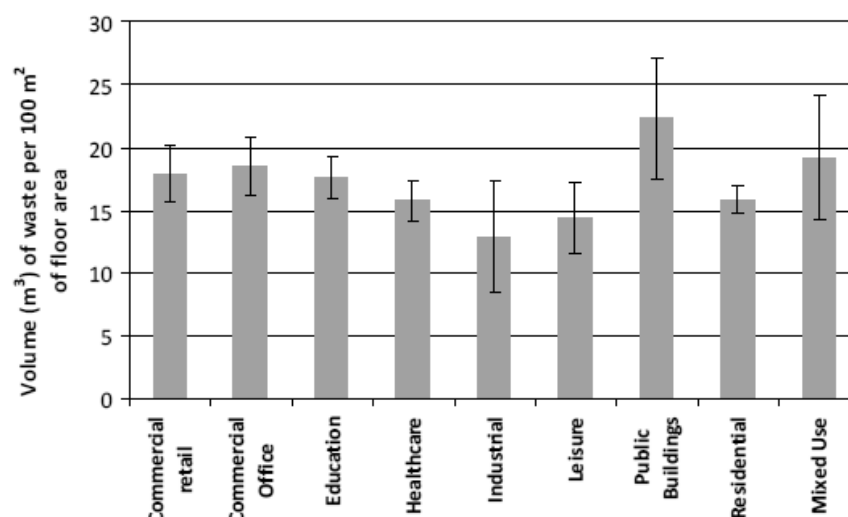
<sup>183</sup> WRAP 2009: Site Waste Management Plans impacts survey 2009:

<http://www.wrapni.org.uk/sites/files/wrap/SWMP%20Impacts%20Survey%20Final%20Report.pdf>

<sup>184</sup> EC Reference Document on Best Environmental Management Practice in the building and construction sector (2012):

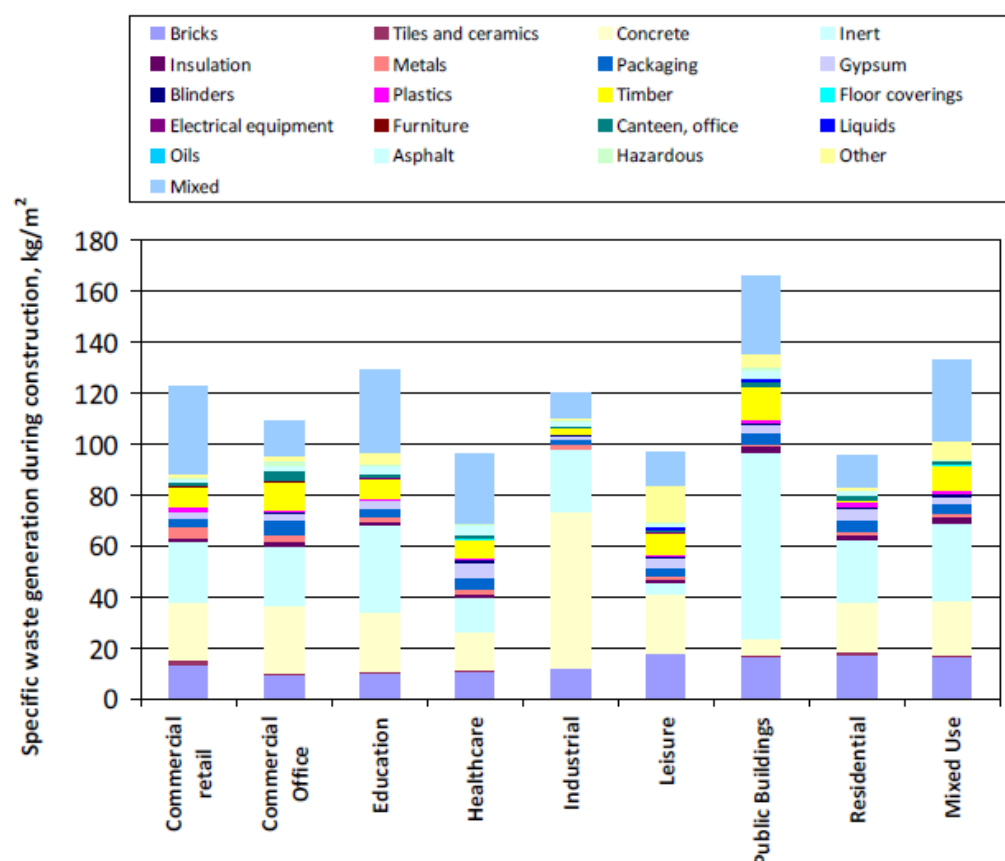
<http://susproc.jrc.ec.europa.eu/activities/emas/documents/ConstructionSector.pdf>

<sup>185</sup> Construction Resources and Waste Platform, 2010. Benchmarks and Baselines 2009. Report, available at [www.wrap.org.uk](http://www.wrap.org.uk)



Source: CRWP (2010)

**Figure 2.17. Waste generation during construction for different types of buildings**



Source: CRWP (2010) and European Commission (2012)

**Figure 2.18. Waste generation per type during construction of different types of buildings (in volume and mass units)**

The survey data referred to previously had been used as a reference for the BREEAM 2011 building assessment system for offices. The data captured using the SMARTWaste system<sup>186</sup> has been used to set benchmarks for resource efficiency in site waste management. As shown in Table 2.16, up to three credits

<sup>186</sup> SMARTwaste, [www.smartwaste.co.uk](http://www.smartwaste.co.uk)

could be assigned within the overall BREEAM assessment to non-hazardous construction waste generated by the building's design and construction if the resource efficiency benchmarks are met or exceeded. Demolition and excavation waste are excluded from this evaluation. It can be seen that 11 tonnes of generated waste represents a resource efficiency benchmark in the top 50% amongst projects and 6-7 tonnes in the top 25% of projects.

**Table 2.16. Resource efficiency benchmarks set in BREEAM for waste generation <sup>187</sup>**

BREEAM credits	Amount of waste generated per 100m <sup>2</sup> (gross internal floor area)		Suggested performance benchmarks
	m <sup>3</sup>	tonnes	
One credit	≤ 13.3	≤ 11.1	in the top 50% of projects (better than standard practice)
Two credits	≤ 7.5	≤ 6.5	in the top 25% of projects (good practice)
Three credits	≤ 3.4	≤ 3.2	in the top 10% of projects (best practice)
Exemplary Level	≤ 1.6	≤ 1.9	in the top 5% of projects (exemplary practice)

Note - Volume (m<sup>3</sup>) is actual volume of waste (not bulk volume)

In line with the above mentioned results, it is proposed that the site waste management plan (SWMP) shall establish systems for the separate collection of materials on-site for re-use, recycling and other forms of recovery and it shall encompass the following materials:

- Construction products that form main building elements, including timber, glass, metal, brick, ceramics, concrete and inert waste, as well as associated packaging materials.
- Construction products that form part of the building fit-out, including flooring, ceiling tiles, plaster and gypsum panels, plastic profiles and insulation materials, as well as associated packaging materials.

Moreover, with reference to literature results, the following performance requirements are proposed:

- Waste arisings during construction and renovation, and excluding demolition waste, shall be less than or equal to 11 tonnes per 100m<sup>2</sup> gross internal office floor area as Core criterion
- Waste arisings during construction and renovation, and excluding demolition waste, shall be less than or equal to 7 tonnes per 100m<sup>2</sup> gross internal office floor area as Comprehensive criterion.

The 25% and 50% performance benchmarks lie within the range reported by Mália et al (2013) for reinforced concrete non-residential buildings. However, the 50% of performance benchmark is significantly higher than the reported median (5 tonnes per 100 m<sup>2</sup>) for a wider range of construction systems, suggesting that further feedback and data is required from stakeholders to cross-check that these benchmarks are representative for other Member States.

#### 2.3.5.2.2 Final criteria proposal

Core criteria	Comprehensive criteria
<b>TECHNICAL SPECIFICATIONS</b>	
<p><b>D3. Site waste management</b></p> <p>Waste arisings during construction and renovation, and excluding demolition waste, shall be less than or equal to 11 tonnes per 100m<sup>2</sup> gross internal office floor area.</p> <p>A site waste management plan shall be prepared prior to the commencement of work on-site. The plan shall establish systems for the separate collection of materials on-site for re-use, recycling and other forms of recovery. The site waste management plan shall encompass:</p> <ul style="list-style-type: none"> <li>(i) Construction products that form main building elements, including timber, glass, metal, brick, ceramics, concrete and inert waste, as well as associated packaging materials.</li> <li>(ii) Construction products that form part of the building fit-out, including flooring, ceiling tiles, plaster and gypsum panels, plastic profiles and insulation</li> </ul>	<p><b>D3. Site waste management</b></p> <p>Waste arisings during construction and renovation, and excluding demolition waste, shall be less than or equal to 7 tonnes per 100m<sup>2</sup> gross internal office floor area.</p> <p>A site waste management plan shall be prepared prior to the commencement of work on-site. The plan shall identify opportunities for waste prevention and shall establish systems for the separate collection of materials on-site for re-use, recycling and other forms of recovery. The site waste management plan shall encompass:</p> <ul style="list-style-type: none"> <li>(i) Construction products that form main building elements, including timber, glass, metal, brick, ceramics, concrete and inert waste, as well as associated packaging materials.</li> <li>(ii) Construction products that form part of the building fit-out, including flooring, ceiling tiles,</li> </ul>

<sup>187</sup> [http://www.breeam.org/BREFAM2011SchemeDocument/content/10\\_waste/wst01.htm#Construction\\_waste\\_groups](http://www.breeam.org/BREFAM2011SchemeDocument/content/10_waste/wst01.htm#Construction_waste_groups)

<p>materials, as well as associated packaging materials.</p> <p>Separate material collection for re-use, recycling and recovery shall respect the waste hierarchy in Directive 2008/98/EC.</p> <p><b>Verification:</b></p> <p>The lead construction contractor, Design &amp; Build contractor or DBO contractor shall submit a site waste management plan consisting of:</p> <ul style="list-style-type: none"> <li>(i) A bill of materials with estimates for waste arisings based on good practices,</li> <li>(ii) Estimates of the % re-use potential based on separate collection during the construction process,</li> <li>(iii) An estimation of the % recycling and recovery potential based on separate collection,</li> </ul> <p>A system shall be used to monitor and account for waste arisings and to track the destination of consignments of waste. Monitoring data shall be provided to the contracting authority.</p>	<p>plaster and gypsum panels, plastic profiles and insulation materials, as well as associated packaging materials.</p> <p>Separate material collection for re-use, recycling and recovery shall respect the waste hierarchy in Directive 2008/98/EC.</p> <p><b>Verification:</b></p> <p>The lead construction contractor, Design &amp; Build contractor or DBO contractor shall submit a site waste management plan consisting of:</p> <ul style="list-style-type: none"> <li>(i) A bill of materials with estimates for waste arisings and the potential for waste prevention based on good practices,</li> <li>(ii) Estimates of the % re-use potential based on separate collection during the construction process,</li> <li>(iii) An estimation of the % recycling and recovery potential based on separate collection,</li> </ul> <p>A system shall be used to monitor and account for waste arisings and to track the destination of consignments of waste. Monitoring data shall be provided to the contracting authority.</p>
<p><b>CONTRACT PERFORMANCE CLAUSE</b></p>	
<p><b>D8. Site waste management</b></p> <p>Operation of the agreed site waste management plan shall be monitored and reported on during progress of construction work on-site. This shall include data accounting for the weight of materials collected by the separate collection of materials on-site for re-use and recycling according to the scope described in the technical specifications.</p> <p>A system shall be used to monitor and quantify waste arisings and materials segregated for recycling and re-use. It shall also track and verify the destination of consignments of waste. The monitoring and tracking data shall be provided to the contracting authority. on an agreed periodic basis.</p>	<p><b>D8. Site waste management</b></p> <p>Operation of the agreed site waste management plan shall be monitored and reported on during progress of construction work on-site. This shall include data accounting for the weight of materials collected by the separate collection of materials on-site for re-use and recycling according to the scope described in the technical specifications.</p> <p>A system shall be used to monitor and quantify waste arisings and materials segregated for recycling and re-use. It shall also track and verify the destination of consignments of waste. The monitoring and tracking data shall be provided to the contracting authority. on an agreed periodic basis.</p>

Summary rationale:

- According to Osmani et al., 2008<sup>188</sup>, on average 33 % of waste generation in a construction site is the responsibility of a failure to implement waste prevention measures during both the design and preliminary construction phases. A site waste management plan (SWMP) has been identified as an important tool to enable the planning, monitoring and management of waste during construction.
- The SWMP includes a bill of materials with estimates for waste arisings and the potential for waste prevention based on good practices. Moreover, the SWMP includes the estimation of the % re-use potential based on separate collection during the construction process and of the % recycling and recovery potential based on separate collection. If properly used, the SWMP can bring significant benefits in terms of economic savings and project planning. Prevention of waste through better design, waste segregation, recycling of waste produced and re-use of materials on site are the top identified actions.
- Average values around 15-20 m<sup>3</sup> of waste per 100 m<sup>2</sup> (around 10-15 t/100 m<sup>2</sup>) have been identified from literature. Moreover, in the BREEAM system, in which data from hundreds of real life projects are reflected, 11 tonnes represents a resource efficiency benchmark in the top 50%

<sup>188</sup> Osmani, M., Glass, J., Price, A.D.F., 2008. Architects' perspectives on construction waste reduction by design. Waste Management 28, 1147-1158

amongst projects and 6-7 tonnes in the top 25% of projects. Demolition and excavation waste are excluded from this evaluation.

- In conclusion, it is proposed that the SWMP shall establish systems for the separate collection of construction products that form part of the main building elements (including timber, glass, metal, brick, ceramics, concrete and inert waste, as well as associated packaging materials) and of the building fit-out (including flooring, ceiling tiles, plaster and gypsum panels, plastic profiles and insulation materials, as well as associated packaging materials).
- Moreover, the following performance requirements are proposed on waste arisings during construction and renovation, and excluding demolition waste,
  - o less than or equal to 11 tonnes per 100m<sup>2</sup> gross internal office floor area as technical specification for Core criterion
  - o less than or equal to 7 tonnes per 100m<sup>2</sup> gross internal office floor area as technical specification for Comprehensive criterion.

### 2.3.5.3 At what stage of the procurement process are the criteria relevant?

It has to be underlined that to fully benefit from waste reduction and recovery on a project, good practice must be adopted at the earliest possible stage (preliminary scoping and feasibility), and planned actions, metrics and targeted outcomes shall be communicated between the contracting authority and tenderers and passed down through the supply chain (including the design teams, subcontractors, waste management contractors and material suppliers) and across all project phases.

Waste management planning has been split into demolition waste management plan and site waste management plan, proposed both as technical specifications (both in Core and Comprehensive criteria). The criteria on the demolition waste management plan should be applied during the strip-out, demolition and site preparation works procurement phase, whilst the criteria on the site waste management plan should be applied during the construction of the building or major renovation works procurement phase.

With reference to the demolition waste management plan, the lead *construction contractor, Design & Build contractor or DBO contractor* shall carry out and submit a pre-demolition/strip-out audit that contains the specified information on what can be re-used, recycled (for Core and Comprehensive criteria) or recovered (only for Core criteria). With reference to the demolition waste management plan, the lead *construction contractor, Design & Build contractor or DBO contractor* shall submit the site waste management plan.

For both criteria, waste arisings shall be accounted for and monitored, including information on the transportation distances of waste and end-of-waste materials (only in the case of the demolition waste management plan) using consignment notes and invoices. Monitoring data shall be provided to the contracting authority.

The criteria classification, their reference numbers in the criteria document and the respective procurement phase can be cross-referenced as follows.

Title of the criterion	Procurement phase	Criterion classification	Criteria typology	Reference number in the criteria document
Demolition waste audit and management plan	C. Strip-out, demolition and site preparation works	Core and Comprehensive	Technical specifications	C1.
Commissioning of site waste management	D. Construction of the building or major renovation works	Core and Comprehensive	Technical specifications	D3.
Site waste management	D. Construction of the building or major renovation works	Core and Comprehensive	Contract performance clauses	D8.



## 2.4 Other environmental criteria

### 2.4.1 Space/design of facilities

#### 2.4.1.1 Recyclable waste storage

##### 2.4.1.1.1 Background technical discussion and rationale

In order to support the reuse, recycling and recovery of secondary materials during occupation of the building, dedicated storage space should be designed into the building, or within the curtilage of the building, to facilitate the segregation of recyclable materials and end-of-life products by occupiers. In this way, recyclable waste streams can be diverted from landfill or incineration. Most of the waste will consist of paper and carton, plastic, metal and glass.

According to BREEAM 2011<sup>189</sup>, the dedicated storage space to cater for recyclable materials generated by the building during occupation should be:

- clearly labelled for recycling. Moreover, individual recycling bins located at convenient locations throughout the building are necessary to maximise recycling rates;
- placed within accessible reach of the building and
- in a location with good vehicular access to facilitate collections. Indeed, where the facilities are situated internally, vehicular gate heights/widths and manoeuvring and loading space must be sized correctly to ensure ease of access for vehicles collecting recyclable materials.

The size of the space allocated must be adequate to store the likely volume of recyclable materials generated by the building's occupants/operation. For example, in BREEAM 2011 for New Construction, the following sizes are provided for office buildings:

- At least 2m<sup>2</sup> per 1000m<sup>2</sup> of net floor area for buildings <5000m<sup>2</sup>
- A minimum of 10m<sup>2</sup> for buildings ≥5000 m<sup>2</sup>
- An additional 2m<sup>2</sup> per 1000m<sup>2</sup> of net floor area where catering is provided (with an additional minimum of 10m<sup>2</sup> for buildings ≥5000m<sup>2</sup>).

Moreover, the separation and storage of waste should be in compliance with the local waste collection scheme provided by the local municipality or privately contracted service.

The French building assessment scheme HQE makes specific reference in its criteria to 'activity waste management' services to be provided upon occupation of the building and to the sizing of rooms or areas for storage. Credits can be awarded for:

- Making links to existing recycling channels that will achieve 50% or 100% waste recycling;
- Providing organic waste recycling, including the potential for on-site recycling units;
- Adequate sizing of waste storage areas and 'optimised operational flows'.

##### 2.4.1.1.2 Final criteria proposal

Core criteria	Comprehensive criteria
<b>TECHNICAL SPECIFICATION</b>	
<b>B5. Recyclable waste storage</b>  Dedicated storage space shall be provided within the building, or within the curtilage of the building, to facilitate the segregation of recyclable materials and end-of-life products by occupiers (with reference to the requirements in Section F5).  The waste collection area(s) shall be sized based on the likely level of occupation in order to accommodate sufficient containers to maximise recycling whilst also handling residual waste.	<b>B5. Recyclable waste storage</b>  Dedicated storage space shall be provided within the building, or within the curtilage of the building, to facilitate the segregation of recyclable materials and end-of-life products by occupiers (with reference to the requirements in Section F5).  The waste collection area(s) shall be sized based on the likely level of occupation in order to accommodate sufficient containers to maximise recycling whilst also handling residual waste.

<sup>189</sup> BREEAM 2011 for New Construction: [http://www.breeam.org/breeamGeneralPrint/breeam\\_non\\_dom\\_manual\\_3\\_0.pdf](http://www.breeam.org/breeamGeneralPrint/breeam_non_dom_manual_3_0.pdf)



<b>Verification:</b>  Design teams or contractors shall provide plans of the building showing the space(s) that have been designated for waste segregation and collection as well as the assumptions made in order to estimate the space provision.	<b>Verification:</b>  Design teams or contractors shall provide plans of the building showing the space(s) that have been designated for waste segregation and collection as well as the assumptions made in order to estimate the space provision.
<b>CONTRACT PERFORMANCE CLAUSES</b>	
<b>F7. Recyclable waste storage</b>  Upon completion it shall be confirmed that dedicated storage space has been provided within the building, or within the curtilage of the building, to facilitate the segregation of recyclable materials and end-of-life products by occupiers (with reference to the requirements in criterion B6).  The construction contractor, the Design & Build contractor or the DBO contractor shall provide final detailed plans of the recycling facilities as-built.	<b>F7. Recyclable waste storage</b>  Upon completion it shall be confirmed that dedicated storage space shall be provided within the building, or within the curtilage of the building, to facilitate the segregation of recyclable materials and end-of-life products by occupiers (with reference to the requirements in criterion B6).  The construction contractor, the Design & Build contractor or the DBO contractor shall provide final detailed plans of the recycling facilities as-built.

Summary rationale:

- In order to ensure the reuse, recycling and recovery, dedicated storage space for waste as paper and carton, plastic, metal and glasses has to be designed within the building, or within the curtilage of the building.
- The dedicated storage space should be clearly labelled for recycling, placed within accessible reach of the building and in a location with good vehicular access to facilitate collections. The size of the storage space must be adequate to store the likely volume of recyclable materials generated.
- Therefore, a technical specification on the storage of recyclable waste is proposed for both Core and Comprehensive criteria. Moreover, a contract performance clause is proposed upon completion of the building.

## 2.4.1.2 Waste management system

### 2.4.1.2.1 Background technical discussion and rationale

During the use phase of the building, the waste generated will consist mainly of packaging materials such as paper and carton, plastic, metal (aluminium cans), glasses, etc. as well as bulky waste such as end of life furniture and WEEE such as IT equipment. The implementation of a waste management system for the use phase can reduce the environmental impacts caused by waste generation. This plan should be based on the waste reduction, reuse and recycling and on waste separated collection, removal and storage.

Therefore, it is suggested as Core criterion that the building manager implements a waste management system that allow occupiers to make a basic segregation of paper, cardboard, and food and drink packaging (glass, plastic and tetrapak) for recycling. Batteries, ink and toner cartridges, IT equipment and furniture also have to be collected and arranged for re-use or recycling where permitted by the availability of services. Space provision for storage within the offices and bin stores shall be adequately planned for and clearly labelled.

In the case of the Comprehensive criterion, basic segregation shall be carried out by both the occupiers and the on-site catering services, including food/catering waste for recycling.

Finally, monthly data quantifying waste arisings as a proportion of the overall waste arisings from the building and in kg per waste fraction should be provided to the contracting authority.

#### 2.4.1.2.2 Final criteria proposal

Core criteria	Comprehensive criteria
<b>TECHNICAL SPECIFICATION</b>	
<p><b>G3. Waste management system</b></p> <p>The building manager shall implement systems that allow occupiers to segregate paper, cardboard, food and drink packaging (glass, plastic and other materials for which local separate collection systems exist) into separate streams for recycling. Batteries, ink and toner cartridges, IT equipment and furniture shall also be collected and arranged for re-use or recycling where possible.</p> <p><b>Verification:</b></p> <p>Facilities managers <i>or</i> DBO contractors shall submit a proposal for the systems to be used, including details of the waste streams, the segregation systems, working arrangements and contractors to be used.</p>	<p><b>G3. Waste management system</b></p> <p>The building manager shall implement systems that allow occupiers and on-site catering services to segregate paper (at least two grades), cardboard, food and drink packaging (glass, plastic and other materials for which local separate collection systems exist) and food/catering waste into separate streams for recycling. Batteries, ink and toner cartridges, IT equipment and furniture shall also be collected and arranged for re-use or recycling where possible.</p> <p><b>Verification:</b></p> <p>Facilities managers <i>or</i> DBO contractors shall submit a proposal for the systems to be used, including details of the waste streams, the segregation systems, working arrangements and contractors to be used.</p>
<b>CONTRACT PERFORMANCE CLAUSE</b>	
<p><b>G5. Waste management system</b></p> <p>The building manager shall monitor and quantify on an ongoing agreed basis the overall waste arisings and recycling rate for the building(s).</p> <p>Facilities managers <i>or</i> DBO contractors shall provide the contracting authority with monthly data quantifying waste arisings as a proportion of the overall waste arisings from the building and in kg per waste fraction.</p>	<p><b>G5. Waste management system</b></p> <p>The building manager shall monitor and quantify on an ongoing agreed basis the overall waste arisings and recycling rate for the building(s).</p> <p>Facilities managers <i>or</i> DBO contractors shall provide the contracting authority with monthly data quantifying waste arisings as a proportion of the overall waste arisings from the building and in kg per waste fraction.</p>

#### Summary rationale:

- During the use phase of the building, the generated waste will consist mainly of packaging materials. The development of a waste management system can reduce the environmental impacts caused by these waste.
- It is suggested as technical specification in the Core criteria that the building manager implements a waste management system that allows occupiers to make a basic segregation of paper, cardboard, and food and drink packaging (glass, plastic and other materials for which local separate collection systems exist) for recycling. Batteries, ink and toner cartridges, IT equipment and furniture shall also be collected and arranged for re-use or recycling where possible.
- The collection of food waste is considered to be more specialised and is therefore proposed as a comprehensive requirement. In case of the Comprehensive criterion, the basic segregation therefore has to be carried out both by the occupiers and the on-site catering services, including food/catering waste for recycling.

#### 2.4.1.3 At what stage of the procurement process are the criteria relevant?

The evaluation of space/design of facilities has been split into recyclable waste storage and waste management system, proposed both as technical specifications (both in Core and Comprehensive criteria). The criteria on recyclable waste storage shall be applied during the detailed design and performance requirements procurement phase. As contract performance clauses, during the practical completion and handover procurement phase, it shall be confirmed that dedicated storage space has been provided.

The criteria on implementation of a waste management system shall be applied during the facilities management procurement phase.

With reference to recyclable waste storage, the *design teams* or *contractors* shall provide plans of the building showing the space(s) that have been designated for waste segregation and collection as well as the assumptions made in order to estimate the space provision. Moreover, during the practical completion and handover, the *construction contractor*, the *Design & Build contractor* or the *DBO contractor* shall provide final detailed plans of the recycling facilities as-built.

With reference to the waste management system, the facilities managers or DBO contractors (dependant on the form of procurement) shall provide the contracting authority with monthly data quantifying waste arisings as a proportion of the overall waste arisings from the building and in kg per waste fraction.

The criteria classification, their reference numbers in the criteria document and the respective procurement phase can be cross-referenced as follows.

Title of the criterion	Procurement phase	Criterion classification	Criteria typology	Reference number in the criteria document
Recyclable waste storage	B. Detailed design and performance requirements	Core and Comprehensive	Technical specifications	B5.
Recyclable waste storage	F. Practical completion and handover	Core and Comprehensive	Contract performance clauses	F7.
Waste management system	G. Facilities management	Core and Comprehensive	Technical specifications	G3.
Waste management system	G. Facilities management	Core and Comprehensive	Contract performance clauses	G5

## 2.4.2 Water saving installations

### 2.4.2.1 Performance requirements for water saving installations

#### 2.4.2.1.1 Background technical discussion and rationale

According to the estimation made by EUREAU<sup>190</sup>, the average delivery of water for the non-domestic sector in 2012 in the EU28 was 9,881 Mm<sup>3</sup>/yr (around one quarter of the total water delivered). However, the information on the split of water consumption in the non-domestic sector between different uses is limited.. An analysis on the water consumption split between different non-domestic activities and uses in the UK has been carried-out for Defra's Market Transformation Programme<sup>191</sup> and reported in Table 2.17. It is shown that in the case of office buildings, water is used basically for toilets and urinals, taps and, in some cases, for showers.

**Table 2.17. Water use in the non-domestic sector in the UK**

Activity	Water consumption (Mm <sup>3</sup> /yr)	Toilets and urinals	Washbasin taps	Showers/baths	Kitchen taps	Washing machines	Others
Food and drink	261.3	12%	1%	0%	0%	0%	87%
Retail	177.3	14%	2%	0%	1%	0%	83%
Hotels	127.3	8%	7%	9%	2%	0%	74%
Education	115.7	28%	3%	1%	4%	0%	64%
Health and social	29.7	45%	8%	0%	4%	0%	44%
Recreation, culture, sport	6.7	74%	4%	0%	0%	0%	22%
Public administration and defence	11.0	63%	2%	0%	5%	0%	30%
Others	1380.8	4%	1%	0%	0%	0%	94%
Total	2109.831	8.5%	2.0%	0.5%	0.8%	0.0%	88%

<sup>190</sup> EUREAU 2009.

[http://eureau.org/index.php?eID=tx\\_nawsecuredl&u=0&file=fileadmin/user\\_upload/documents/8%20Reports/EUREAU%20Statistics%200-view%20on%20Water%20and%20Wastewater%20in%20Europe%20-%202008%20\(Edition%202009\).pdf&t=1410877211&hash=3e1c7e5224212b5701263fd0135e8e69021fd5a6](http://eureau.org/index.php?eID=tx_nawsecuredl&u=0&file=fileadmin/user_upload/documents/8%20Reports/EUREAU%20Statistics%200-view%20on%20Water%20and%20Wastewater%20in%20Europe%20-%202008%20(Edition%202009).pdf&t=1410877211&hash=3e1c7e5224212b5701263fd0135e8e69021fd5a6)

<sup>191</sup> Defra's Market Transformation Programme 2011. <http://efficient-products.ghkint.eu/spm/download/document/id/959.pdf>

Additionally, from a life cycle perspective according to IPTS's preliminary LCA analysis, water use and management is less important when assessing the whole life of an office building. Also, less performance information can be found per building typology. Different factors (such as climate conditions, presence of water-saving equipment, number of occupants, applicable legislation, existing facilities, etc.) influence on the operational water use within office buildings.

With reference to the MEErP Preparatory Study for Taps and Showers<sup>192</sup>, currently under development by the JRC, water and related energy consumption have been evaluated taking into account water loss and energy demand for water supply system, energy losses in the water heating system and energy demand in waste water treatment system. Moreover, it has been underlined that water consumption from taps and showers is mainly a function of technology and user behaviour, so these should both be a focus for action. In the Task3 on users and system aspects, it has been preliminarily estimated that the total EU28 water saving potential from taps and showers, which could be achieved through a change of products and technology in the short-medium term, is on average equal to 2500 Mm<sup>3</sup>/year. This saving would represent 11% of the total water abstraction for taps and showers in the EU28. 7% of this potential would be in the non-domestic sector.

Moreover, the energy saving from taps and showers in the EU28, which could be achieved a change of products and technology in the short-medium term, has been estimated to be 386 PJ of primary energy per year (131 PJ/year without considering system aspects), 4% of which would be in the non-domestic sector. This saving would represent 13% of the total system demand of primary energy for taps and showers in the EU28.

According to the MEErP study, the majority of the water and energy savings potential relates to the domestic sector. Moreover, a focus on certain typologies of non-domestic buildings, such as sport facilities or schools, could allow for greater water and energy savings than from office buildings.

In 2013, the EC published GPP criteria for sanitary tapware<sup>193</sup> and also for toilets and urinals<sup>194</sup>. Therefore, it is proposed that all sanitary and kitchen water facilities shall be equipped with water efficient fittings that are in compliance with the above-mentioned criteria.

Since the development and publication of the GPP criteria, a number of independent labels have appeared on the market in Member States, such as the European Water Label (EWL). The approach used by these labels was taken into account in the MEErP Preparatory study for Taps and Showers. This study may result in new policy instruments being brought forward, but in the interim it is proposed to refer to the EU GPP criteria.

#### 2.4.2.1.2 Summary of feedback from the stakeholder written consultation

It was highlighted that there is a European Water Label (EWL), which is a voluntary and flexible scheme to measure the water consumption of bathroom products, including ceramic sanitary ware. It was proposed that products carrying the EWL should be awarded with points.

*These comments are addressed in the above-given background discussion and rationale.*

#### 2.4.2.1.3 Final criteria proposal

Core criteria	Comprehensive criteria
<b>TECHNICAL SPECIFICATION</b>	
<b>B6. Water saving installations</b>  All sanitary and kitchen water facilities shall be equipped with water efficient fittings that are in compliance with the criteria for sanitary tapware and toilets and flushing urinals.  EU GPP criteria for sanitary tapware  <a href="http://ec.europa.eu/environment/gpp/pdf/criteria/sanitary/EN.pdf">http://ec.europa.eu/environment/gpp/pdf/criteria/sanitary/EN.pdf</a>	<b>B6. Water saving installations</b>  All sanitary and kitchen water facilities shall be equipped with water efficient fittings that are in compliance with the criteria for sanitary tapware and toilets and flushing urinals.  EU GPP criteria for sanitary tapware  <a href="http://ec.europa.eu/environment/gpp/pdf/criteria/sanitary/EN.pdf">http://ec.europa.eu/environment/gpp/pdf/criteria/sanitary/EN.pdf</a>

<sup>192</sup> JRC ErP Preparatory Study for Taps and Showers: [http://susproc.jrc.ec.europa.eu/taps\\_and\\_showers/stakeholders.html](http://susproc.jrc.ec.europa.eu/taps_and_showers/stakeholders.html)

<sup>193</sup> EU GPP criteria for sanitary tapware: <http://ec.europa.eu/environment/gpp/pdf/criteria/sanitary/EN.pdf>

<sup>194</sup> EU GPP criteria for toilets and urinals: [http://ec.europa.eu/environment/gpp/pdf/criteria/toilets/criteria\\_Toilets\\_en.pdf](http://ec.europa.eu/environment/gpp/pdf/criteria/toilets/criteria_Toilets_en.pdf)

<p>EU GPP criteria for toilets and urinals</p> <p><a href="http://ec.europa.eu/environment/gpp/pdf/criteria/toilets/criteria_Toilets_en.pdf">http://ec.europa.eu/environment/gpp/pdf/criteria/toilets/criteria_Toilets_en.pdf</a></p> <p><b>Verification:</b></p> <p>See the respective EU GPP criteria documents.</p>	<p>EU GPP criteria for toilets and urinals</p> <p><a href="http://ec.europa.eu/environment/gpp/pdf/criteria/toilets/criteria_Toilets_en.pdf">http://ec.europa.eu/environment/gpp/pdf/criteria/toilets/criteria_Toilets_en.pdf</a></p> <p><b>Verification:</b></p> <p>See the respective EU GPP criteria documents .</p>
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Summary rationale:

- From a life cycle perspective, water use and management is less important when assessing the whole life environmental impacts of an office building
- The available information on the split of water consumption in the non-domestic sector between different uses is limited. With reference to office buildings, an analysis on the water consumption split between different non-domestic activities and uses in the UK shows that in the case of office buildings, water is used mainly for toilets and urinals, taps and for showers
- With reference to the ErP Preparatory Study for Taps and Showers<sup>195</sup>, currently under development by the JRC, water and related energy saving can be achieved by acting on both technology and user behaviour. According to this study, the main water and energy savings are related to the domestic sector. Moreover, other typologies of non-domestic buildings than office buildings could allow reaching greater water and energy savings.
- Given that EU GPP criteria have been published in 2013 both for sanitary tapware and for toilets and urinals, and that the results of the MEErP Preparatory study for Taps and Showers are not yet published, it is proposed to include a cross-reference to them for consistency.

#### **2.4.2.2 At what stage of the procurement process are the criteria relevant?**

The evaluation of the water saving installations has been proposed both as technical specifications (both in Core and Comprehensive criteria). This criterion has to be applied during the detailed design and performance requirements procurement phase. The *tenderers* must provide technical specifications for the products to be installed that verify compliance with the appropriate GPP criteria.

The criteria classification, their reference numbers in the criteria document and the respective procurement phase can be cross-referenced as follows.

<b>Title of the criterion</b>	<b>Procurement phase</b>	<b>Criterion classification</b>	<b>Criteria typology</b>	<b>Reference number in the criteria document</b>
Performance requirements of water saving installations	B. Detailed design and performance requirements	Core and Comprehensive	Technical specifications	B6.

<sup>195</sup> JRC ErP Preparatory Study for Taps and Showers: [http://susproc.jrc.ec.europa.eu/taps\\_and\\_showers/stakeholders.html](http://susproc.jrc.ec.europa.eu/taps_and_showers/stakeholders.html)

## 2.5 Office environmental quality criteria

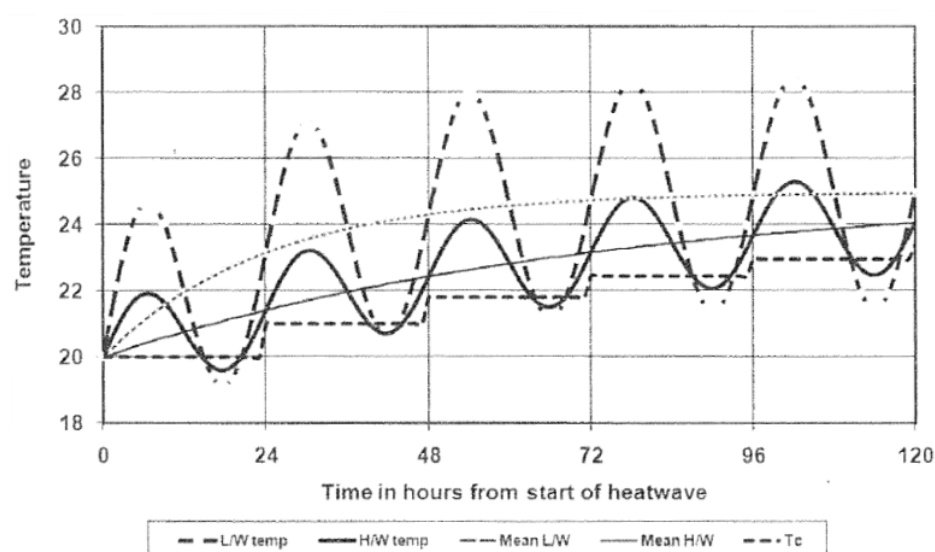
### 2.5.1 Thermal comfort conditions

#### 2.5.1.1 Background technical discussion and rationale

In low energy or passive office buildings, the control of thermal comfort is an important factor. This is because uncontrolled thermal gain from natural lighting and ventilation, as well as insufficient thermal mass within a building's structure, can lead to uncomfortable conditions that may then require additional cooling energy. The recast EPD Directive 2010/31/EU specifically addresses overheating, stating that:

*'...there should be focus on measures which avoid overheating, such as shading and sufficient thermal capacity in the building construction, and further development and application of passive cooling techniques, primarily those that improve indoor climatic conditions and the micro-climate around buildings.'*

Evidence from the performance monitoring of buildings highlights the role features such as thermal mass play in low energy design, as illustrated by the moderating effect of thermal mass on interior temperatures during a heatwave, in Figure 2.19.



**Figure 2.19: Comparison of indoor thermal variation of light weight and heavy weight buildings**

Source: Nicol et al (2012)

Literature based on surveys suggests that although occupants may have a greater tolerance for hot and cold conditions in a low energy building with more passive design features, allowing an 'adaptive' approach to thermal comfort to be adopted that assumes greater tolerance for temperature variations, it has also been shown that occupiers place a significance on being able to control their working conditions to within self-defined parameters<sup>196</sup>.

EN standard 7730 addresses the ergonomics of thermal environments. It provides two metrics, which can be used to estimate occupant comfort (or discomfort) – Predicted Mean Vote (PMV) and Predicted Percentage Dissatisfied (PPD). Both of these metrics are based on a statistical probability of occupants feeling too hot or too cold. They are complex to calculate and interpret, with perception of thermal comfort being influenced by many different factors.

EN standard 15251 provides a simpler set of design parameters for the winter season and summer season, with more or less stringent categories for design minimum and maximum temperatures, with a distinction made between offices with mechanical HVAC systems and passive cooling systems. The latter allows for greater temperature variations, reflecting the adaptive approach to thermal comfort described already.

<sup>196</sup> Wagner A et al, *Thermal comfort and workplace occupant satisfaction—Results of field studies in German low energy office buildings*, Energy and Buildings 39 (2007) 758–769

A dynamic approach to the simulation of a buildings performance is specified in EN ISO 13790 and would provide a more accurate tuning of the building design to monthly, daily and hourly temperature swings. Recognising that this form of modelling requires a higher level of expertise and the use of more advanced software, dynamic simulation according to this standard is considered to be more appropriate as a comprehensive criterion.

### 2.5.1.2 Summary of feedback from the stakeholder written consultation

#### Stakeholder feedback received during the final written consultation

It was emphasised that thermal comfort does not just relate to minimum or maximum values, but also to stable internal temperatures and the avoidance of summertime overheating.

Moreover, the so-called 'adaptive approach' to thermal comfort is based on the premise that occupants can adapt to different thermal environments, which results in an allowance being made in designs for a greater variation in temperatures. To apply Annex 2 it was considered by a stakeholder that occupants should be able to adapt to the internal environment. However, in many cases this was not considered to be possible. For example, it was cited that, depending on the type of office building, it may not be possible to open windows.

Another stakeholder commented that a dynamic simulation linking temperatures and energy use should be used to verify the comprehensive ambition level.

*These comments are addressed in the above-given background discussion and rationale.*

### 2.5.1.3 Final criteria proposal

Core criteria	Comprehensive criteria
<b>TECHNICAL SPECIFICATIONS</b>	
<b>B7.1 Thermal comfort conditions</b> Design indoor temperature values (minimum room temperature in winter, maximum room temperature in summer) for the office building shall comply with at least category II in accordance with EN 15251 or equivalent. Annex A1 shall be referred to for mechanically cooled buildings and A2 for passively cooled buildings.  <b>Verification:</b> Design teams or the Design & Build contractor or the DBO contractor shall provide modelling data for the room temperatures.	<b>B7.1 Thermal comfort conditions</b> Design indoor temperature values (minimum room temperature in winter, maximum room temperature in summer) for the office building shall comply with at least category I in accordance with EN 15251 or equivalent. Annex A1 shall be referred to for mechanically cooled buildings and A2 for passively cooled buildings.  Compliance shall be demonstrated using dynamic thermal simulation modelling carried out according to EN ISO 13790 hourly method or equivalent.  <b>Verification:</b> Design teams or the Design & Build contractor or the DBO contractor shall provide modelling data for the room temperatures.

#### Summary rationale:

- Overheating is an important factor to control in low energy buildings because of the emphasis on the use of natural daylighting and passive ventilation systems.
- Thermal comfort is an important concept because it can influence occupiers acceptance of a low energy building.
- Standard metrics exist to predict thermal comfort but these are complex to calculate and may still not take into account all relevant factors.
- It is proposed that a simplified approach based on maximum and minimum design temperatures is taken, requiring modelling of the thermal conditions within the office building.
- The ambition levels within EN 15251 inform the core and comprehensive technical specifications. The Annex A1 and A2 parameters take into account the extent of the opportunity to apply the so-called 'adaptive approach' to thermal comfort, with A2 reflecting a passive cooling and ventilation strategy.

- For the comprehensive technical specification, an additional requirement to demonstrate compliance using a dynamic thermal simulation model according to EN ISO 13790 hourly method (or equivalent) is proposed, so as to provide an additional validation of the design performance. This will ensure that allowance is also made for factors such as thermal mass that can act to stabilise internal temperatures.

#### 2.5.1.4 At what stage of the procurement process are the criteria relevant?

The thermal comfort conditions requirement has been proposed as a technical specification (both for Core and Comprehensive criteria) to be applied during the detailed design and performance requirements procurement phase. *Design teams* or the *Design & Build contractor* or the *DBO contractor* shall provide modelling data for the room temperatures.

The criteria classification, their reference numbers in the criteria document and the respective procurement phase can be cross-referenced as follows.

Title of the criterion	Procurement phase	Criterion classification	Criteria typology	Reference number in the criteria document
Thermal comfort conditions	B. Detailed design and performance requirements	Core and Comprehensive	Technical specification	B7.1.

## 2.5.2 Daylighting and glare

### 2.5.2.1 Background technical discussion and rationale

In Section 2.1.1.2 the potential to use natural daylight to reduce the need for artificial lighting was highlighted. Natural light has also been shown to contribute to a more conducive and productive working environment and is preferred by office workers, who tend to seek a window location. The plan depth of an office will dictate how much of the floor area can be illuminated with natural light. In a Northern European location and with a building plan depth of more than 4-6 metres, a glazing ratio of 30% and a ceiling height of 3 metres, natural light levels are likely to fall below the level of 500 lux (lumens/m<sup>2</sup>) necessary for a working environment – approximately equivalent to a Daylighting Factor (DF) of 2% from outside light <sup>197</sup>.

It is important to also note that without careful design, natural light can make a working environment uncomfortable and, potentially, result in more energy use than predicted in the original design. Whilst a design may achieve an ideal average Daylighting Factor of 2% at a plan depth of 6 metres, this would result in unwanted glare and thermal gains near the windows, particularly in Southern European countries. As a result, shading may be required to control natural daylight. Shading systems or technologies can be designed to either block light entering (e.g. blinds, reflective glass or coatings), thereby resulting in the need for artificial lighting or, as it can be seen in the examples of passive design, to redistribute natural light deeper into the building (e.g. by reflecting it onto the ceiling using light shelves).

A range of metrics have been developed to measure both useful and discomfort daylight and any associated glare, both on a proportional and dynamic basis<sup>198</sup>. Some of these metrics are used in national building codes, for example the stipulation of minimum Daylighting Factors or a percentage of the surface area of a building that is glazed (e.g. France, UK, Denmark), but in general these tend only to apply to residential buildings and on a guidance basis. The building assessment schemes HQE (France), DGNB (Germany), BREEAM International (EU-wide) and Verde (Spain) set average Daylighting Factors for a percentage of an office's floor area. These schemes stipulate that 80% of a naturally lit room shall achieve DF levels linked to credits to be awarded:

- HQE sets DF 1.2 and 2.5 as criterion levels for external facades, DF 0.7 for interior facing facades and a criterion that 'glare sensitive spaces' shall be identified and that 'proven and satisfactory measures' are used to control glare;
- BREEAM New Construction (International) and Verde 2013 (Spain) set minimum DF with BREEAM providing a range 1.5-2.2 adjusted to latitude. Verde has a complementary criterion on solar control;

<sup>197</sup> Baker, N. and K. Steemers (1999) *Energy and Environment in Architecture: A Technical Design Guide*, Taylor & Francis and European Commission (1994) *Daylighting in buildings*, THERMIE project

<sup>198</sup> Athienitis, A. and W. O'Brien, (2015) *Modelling, design and optimisation of net-zero energy buildings*, Wiley



- DGNB includes reference to glare protection classifications from EN 14501, but these are based on the use of blinds and shutters, so they therefore do not include other potential measures such as solar control glazing.

BREEAM New Construction (International) and LEED v4 (2015) both present a very different approach to DF, having introduced a dynamic approach requiring the modelling of internal spaces on an hourly basis during a year. Three options are given in LEED. The first is to achieve a percentage 'spatial daylight autonomy' of more than 300 lux at desk height for stipulated percentages of the year *and* an 'Annual Sun Exposure' of >1000 lux for <10% of the year. The other two options define an illuminance level of between 300 and 3,000 lux at desk height, either for specific days of the year or as a percentage of the year. BREEAM has the option of achieving an average daylight illuminance of 200 lux for 2650 hours per year for 80% of the office space.

Other metrics exist that define thresholds related to the risk of glare. Useful Daylight Illuminance (UDI) sets an upper and lower lux threshold of 100 and 2000 lux, reflecting levels below which daylight is insufficient or above which there may be visual discomfort, although the basis for the 2000 lux level is unclear. Standard EN 12464 provides a rating for glare from artificial lighting (the Unified Glare Rating), stating that there is currently *no standardised rating of discomfort glare from windows*. This can be seen in the Spanish scheme Verde, which only sets a UGP threshold for electric luminaires. For windows with an identified risk of glare, Verde's associated criterion requires solar control features to be installed e.g. low emissivity glazing or window films, shutters, brise soleil.

Literature comparing and contrasting metrics for measuring glare suggests that Daylight Glare Probability (DGP) represents a possible metric, having been developed based on subjects in real office environments and assessed as being currently the most suitable to estimate glare from both direct and indirect natural light <sup>199</sup>. DGP estimates the number of occupants that may find the level of glare uncomfortable. A threshold of 0.35 relates to 'disturbing' levels of glare and 0.30 to 'perceptible' levels. Recent field trials by Fraunhofer ISE <sup>200</sup> suggested three bands of performance – A (<0.35), B (<0.40) and C (<0.45). It is understood that DGP can be measured using readily available Computer Aided Design (CAD) software plug-ins such as Radiance, DIVA or Evalglare.

### **2.5.2.2 Summary of feedback from the stakeholder written consultation**

A number of stakeholders considered that more consideration should be given to climatic conditions when addressing daylighting and glare control. The dynamic approach now adopted by the international scheme LEED v4 was referred to. A stakeholder emphasised that solar control glazing should be considered before shading, which can reduce daylighting, and comfort cooling, which will increase energy use.

It was commented, based on experience from certified buildings, that the criterion for a minimum 2% daylight factor over 80% of the office space is extremely difficult to achieve, especially in city centres. A UK study of BREEAM certified buildings was referred to, which found that only 20% met the BREEAM criterion of 2% *average* daylight factor. Concern was raised that the unintended consequence of the criterion could be overglazing, especially in Southern Europe, and an associated risk of overheating or excessive cooling loads. If a DGP of 0.30 or lower were to be required as well, this would make the criterion even more difficult to achieve.

The use of DGP was queried by one stakeholder on the basis that the exact position of occupants would need to be modelled and that, since the glare may originate from different sources (e.g. reflexion, contrast, direct sunlight) and can be partitioned between disability and discomfort glare, this would mean that the vertical eye level disturbance was not fully reliable. It was proposed instead that additional criteria should be used to calculate the real risk of glare e.g. Useful Daylight Illuminance UDI or Annual Sun Exposure (ASE).

*These comments are addressed in the above-given background discussion and rationale.*

<sup>199</sup> Wienold, A. and J. Christoffersen, *Evaluation methods and development of a new glare prediction model for daylight environments with the use of CCD cameras*, Energy and Buildings 38 (2006) 743–757 and Harvard Design School, *The Use of Glare Metrics in the Design of Daylit Spaces: Recommendations for Practice*, 9th International Radiance Workshop, September 20–21, 2010

<sup>200</sup> Wienold, J. (2013) *Glare analysis and metrics*, Fraunhofer-Institut für Solare Energiesysteme ISE

### 2.5.2.3 Final criteria proposal

Core criteria	Comprehensive criteria
<b>TECHNICAL SPECIFICATIONS</b>	
<p><b>B7.2 Daylighting and glare control</b></p> <p>Useable office space shall for 80% of the useable floor area achieve an average Daylight Factor of 1.5% for externally facing facades and 0.7% for interior facing facades.. Both shall be measured at a working plane height which shall be defined by the contracting authority.</p> <p>Locations within the building that may be sensitive to glare shall be identified and control measures to limit direct or indirect glare in these locations shall be specified.</p> <p><b>Verification:</b> Design teams or the Design &amp; Build contractor or the DBO contractor shall provide modelling data for daylighting conditions and glare identification together with a glare control strategy.</p>	<p><b>B7.2 Daylighting and glare control</b></p> <p>Dynamic modelling shall be used to demonstrate that during a year the useable office space achieves for a minimum of 55% of the occupied hours:</p> <ul style="list-style-type: none"> <li>- Spatial Daylight Autonomy of <math>\geq 300</math> lux on the working plane, and;</li> <li>- A Daylight Glare Probability value of <math>\leq 40\%</math> for locations that exceed 1000 lux (without solar control measures installed).</li> </ul> <p>Both shall be measured at a working plane height which shall be defined by the contracting authority. DGP shall be measured for views of the windows at eye level.</p> <p><b>Verification:</b> Design teams or the Design &amp; Build contractor or the DBO contractor shall provide a summary report based on one years' modelling data for daylighting and glare levels.</p>

#### Summary rationale:

- A core criterion is proposed based on achievement of a minimum Daylighting Factor for a proportion of the useable office floor area. The use of DF reflects current practice but the shortcomings of DF are addressed by also requesting identification of locations at risk of discomfort glare in order to avoid occupier discomfort and building overheating.
- A comprehensive technical specification is proposed requiring that the potential for natural daylighting is maximised by achieving a minimum, useful lux level on a notional work surface. This is made more ambitious than the core criterion by requiring dynamic modelling for a whole year.
- Modelling on a dynamic basis for a whole year is generally seen as the most progressive and realistic means of verifying the daylighting performance, reflecting current industry best practice as evidenced by adoption of this method by BREEAM and LEED.
- Both the core and comprehensive criteria will incentivise designers to adjust plan depths to locate useable areas within sufficient proximity of windows and to optimise facade designs so that natural light reaches workstations and/or is reflected, diffused and redistributed at times of the year when solar control is required.
- Glare is an important aspect to control as excessive daylight can cause discomfort and contribute to overheating. In order to ensure that glare is controlled, it is proposed that a second metric is introduced in the comprehensive technical specification that measures the level of discomfort of occupants.
- Daylight Glare Probability is understood to currently be the most accepted methodology for measuring glare at eye level, however, it is to be recognised that it is a relatively new metric. A Daylight Glare Probability threshold of 0.40 is proposed as representing a level above which glare is uncomfortable for many office workers. Recognising that this is a relatively new metric the requirement focusses on those locations with most potential for discomfort glare.
- This criterion would complement the criterion on lighting control systems, which specifies the use of daylight-linked dimmers, thereby allowing the use of artificial lighting to be reduce in function of the availability of natural light. The *combined* savings potential has been estimated at 20-30% of artificial lighting requirements.

#### 2.5.2.4 At what stage of the procurement process are the criteria relevant?

The daylighting and glare has been proposed as a technical specification (both for Core and Comprehensive criteria) to be applied during the detailed design and performance requirements procurement phase. *Design teams* or the *Design & Build contractor* or the *DBO contractor* shall provide modelling data for daylighting conditions and glare control.

The criteria classification, their reference numbers in the criteria document and the respective procurement phase can be cross-referenced as follows.

Title of the criterion	Procurement phase	Criterion classification	Criteria typology	Reference number in the criteria document
Daylighting and glare	B. Detailed design and performance requirements	Core and Comprehensive	Technical specification	B7.2.

### 2.5.3 Air quality

#### 2.5.3.1 Ventilation and air quality

##### 2.5.3.1.1 Background technical discussion and rationale

Building occupiers can be exposed to a range of potential sources of hazardous substances arising from building materials, furnishings, decorative materials, cleaning agents, humidity, combustion equipment and external air pollution. Studies have suggested that healthy indoor air quality is a factor that can improve productivity. Conversely, the problem of so-called 'sick building syndrome' can lead to reduced productivity and even lost time due to work-related illness.

As workers' salaries represent the greatest expenditure (significantly bigger than energy use), improvements in the quality of an office environment can potentially be attributed a financial value. Research suggests that by increasing ventilation rates from 2.5 l/s to 10 L/s per person, productivity can be increased by around 5%<sup>201</sup>. Related to this, productivity has been observed to increase by approximately 1% for every 10% reduction in dissatisfaction with the indoor air quality. Indoor air quality can therefore be seen as an important measure of the health of a building.

DG Health & Consumers has identified fine particulate matter from outdoor air pollution and indoor combustion equipment as the most significant source of indoor exposure<sup>202</sup>. This finding is supported by the European Collaborative Action (ECA) on 'Urban air, indoor environment and human exposure' and EU monitoring projects such as Officair. It therefore warrants a specific focus of attention in the EU GPP criteria.

Important factors that dictate the quality of intake air in an office are the external environment, the level of air filtration and the ventilation rate. EN standard 13779 specifies design criteria for ventilation systems to maintain indoor air quality, including specifications to reduce the intake of urban pollution and improve the filtration of the air that is circulated within the building. Requirements from the standard are, to some extent reflected in the building certification schemes BREEAM, which contain criteria that awards credits if the ventilation intakes are located over 20 metres from external pollutant sources and are over 10 metres apart to avoid the recirculation of exhaust air. This is stricter than the guidance in EN 13779, which in Appendix A2.2 suggests 8 metres.

Poor urban air quality is described in EN 13779 as locations where '*...pollutant concentrations exceed the WHO guidelines or any National air quality standards or regulations for outdoor air by a factor greater than 1.5.*' Because under the Air Quality Directive 2008/50/EC Member States are required to prepare air quality action plans and monitor pollution at a local level, it is anticipated that this information should be readily available from a local municipality or from reported data in the public domain.

Stakeholders commented that specific requirements should be set for indoor air quality based on quality classes. WHO IAQ guidelines exist for the level of indoor exposure levels for a number of indoor air contaminants, including PM2.5 particulates, CO, NO<sub>2</sub>, formaldehyde, benzene and naphthalene. Some of these emissions can be attributed to the fitout of a building. Specific contaminants associated with fit out are addressed in Section 1.10.3.2.

<sup>201</sup> Djukanovic et al, *Cost benefit analysis of improved air quality in an office building*, Proceedings: Indoor Air 2002

<sup>202</sup> DG Health & Consumers (2011) *Promoting actions for healthy indoor air*.

The German building assessment scheme DGNB's CORE 14 indoor air quality criteria may be relevant as they include sub-criterion setting occupancy-based ventilation rates and air quality benchmarks according to EN 15251. The latter standard provides a four level rating of indoor air quality, with benchmarking based on a choice from three different methods – per person ventilation rate, per floor area ventilation rate and CO<sub>2</sub> levels.

#### 2.5.3.1.2 Summary of feedback from the stakeholder written consultation

Evidence was submitted by one stakeholder that air filter performance influences the overall energy efficiency of air filtration systems for buildings. This is because of the potential for a drop in pressure across a filter. A 10% reduction in pressure drop was outlined as being feasible according to filter products on the EU market. The European industry certifies filters to agreed EN standards, as well as a more recent energy efficiency rating system which relates to different classes of filters as defined by EN 779.

Another stakeholder emphasised that the criterion does not set out any specific goals for the quality class of the indoor air in the building. Reference was made to the criteria within the DGNB assessment scheme.

A stakeholder queried the practical benefit of the required distance of 20 metres from urban pollution sources.

*These comments are addressed in the above-given background discussion and rationale.*

#### 2.5.3.1.3 Final criteria proposal

Core criteria	Comprehensive criteria
TECHNICAL SPECIFICATIONS	
<p><b>B7.3 Ventilation and air quality</b></p> <p>The ventilation system shall be specified to supply indoor air with a quality rating of IDA 2 according to EN 15251 or equivalent.</p> <p>In locations with poor outdoor air quality, the ventilation systems of the building shall be designed to ensure that clean air is supplied to the offices in compliance with the following criterion:</p> <ul style="list-style-type: none"> <li>- No air intake should be positioned on a façade or facades exposed to busy roads (<i>road to be indicated in the ITT</i>). Where this is not possible, the opening should be positioned as high above the ground as possible. The design shall additionally be in compliance with guidance A2.2 in EN 13779;</li> <li>- Ventilation system filters shall be in compliance with the specifications in table A.5 of EN 13779 or equivalent;</li> </ul> <p>Poor air quality is defined as outdoor air (ODA) class 2 or 3 according to EN 13779 or equivalent.</p> <p><b>Verification:</b></p> <p>The design team or the DBO contractor shall demonstrate the buildings compliance with the IDA quality rating criteria in EN 15251 or equivalent. Drawings and plans of the ventilation services detailing the air intake locations shall be provided. These shall be provided at the detailed design stage and upon completion. They shall also obtain local air monitoring data from the local public authority enabling classification the location according to EN 13779.</p>	<p><b>B7.3 Ventilation and air quality</b></p> <p>The ventilation system shall be specified to supply air with a quality rating of IDA 1 according to EN 15251 or equivalent.</p> <p>In locations with poor outdoor air quality the ventilation systems of the building shall be designed to ensure that clean air is supplied to the offices in compliance with the following criterion:</p> <ul style="list-style-type: none"> <li>- Air intakes shall be located at least 20 metres<sup>203</sup> from sources of poor air quality (as defined below). Where this is not possible, the opening should be positioned as high above the ground as possible. The design shall additionally be in compliance with guidance A2.2 in EN 13779;</li> <li>- Ventilation system filters shall be in compliance with the specifications in table A.5 of EN 13779 or equivalent;</li> </ul> <p>Poor air quality is defined as outdoor air (ODA) class 2 or 3 according to EN 13779 or equivalent.</p> <p><b>Verification:</b></p> <p>The design team or the DBO contractor shall demonstrate the buildings compliance with the IDA quality rating criteria in EN 15251 or equivalent. Drawings and plans of the ventilation services detailing the air intake locations shall be provided. These shall be provided at the detailed design stage and upon completion. They shall also provide local air monitoring data from the local public authority enabling classification of the location according to EN 13779.</p>

<sup>203</sup> This should be the geometric distance measured over the surfaces of the public realm and the building and not a linear distance from point to point. Sometimes this may be referred to in Computer Aided Design (CAD) as a multiple or segmented line, or a polyline.

### Summary rationale:

- The quality classes laid down in EN 15251 are proposed as an overall benchmark for the quality of indoor air, with ratings or IDA 2 and 1 proposed, which are in line with those referred to in a criterion of the building assessment scheme DGNB.
- The intake by office ventilation systems of urban air pollution and contaminants has been identified as a significant contaminant of indoor air. Fine particulates from vehicle exhaust are of particular concern.
- The EN standard 13779 specifies technical standards for the location of air intakes to minimise the intake of polluted outdoor air and to filter and recirculate air to a high standard. This approach is followed by the BREEAM building certification scheme, which sets stricter requirements for the distance of intakes from sources of pollution.
- It is proposed as a technical specification (Core and Comprehensive) that in locations with poor air quality (as defined by EN 13779) the stipulated guidance on the location of the building's ventilation intakes and the specifications for ventilation system filters are met.
- The stricter BREEAM requirement for location of air intakes at least 20 metres from sources of poor air quality is established as a Comprehensive requirement.

## **2.5.3.2 Selection of fit-out materials and finishes**

### **2.5.3.2.1 Background technical discussion and rationale**

As was highlighted in Section 2.4.3.1, building occupants may be exposed to a wide range of air borne contaminants. These may include volatile and carcinogenic organic compounds that are emitted from materials and products used in the finishing of building interiors. The most significant potential emissions sources are understood to be paints and varnishes, textile furnishings, floor coverings and fit-out incorporating particle board <sup>204</sup>.

The monitoring and control of emissions from priority chemicals, including Volatile Organic Compounds (VOC's), has been the focus of action at EU level. Work is ongoing to support the CE marking of products under the Construction Products Regulation with two relevant areas of focus - the harmonisation of health-based evaluations of emissions from construction products and the development of an emissions performance class system for reporting to consumers.

This work led to the publication in early 2014 of harmonised and interim Lowest Concentration of Interest (LCI) values for VOC and SVOC substances and compounds of concern based on existing German AgBB and French ANSES systems which apply to construction and fit-out materials<sup>205</sup>. Whilst LCI system provides a robust basis for substance-specific restrictions, there does not always appear to be equivalence between this approach and current product labelling schemes originating in Scandinavia, Germany, Austria, France and the USA, which combine substance-specific LCI's with overall thresholds for VOC and SVOC emissions <sup>206</sup>.

Work facilitated by JRC IHCP is still ongoing to establish common performance classes for emissions from products. This would reflect the approach adopted by France as a legal labelling requirement for a range of interior products <sup>207</sup>, which has four classes of performance. The French scheme comprises performance classes for Total VOCs (TVOC) and ten specific organic substances.

A further related development is the publication in 2013 of a harmonised European test method for emissions of volatile organic compounds from construction products into indoor air, CEN/TS 16516. This established a common method and test conditions based on a 'European reference room' in which products are to be tested. The technical specification was developed in response to a mandate to address dangerous substances under the Construction Products Regulation.

Feedback from industry during revisions of the EU Ecolabel criteria for furniture and wooden floor coverings has highlighted the difficulty in achieving very low levels of TVOC and formaldehyde emissions. This is in part

<sup>204</sup> Bluyssen et al, *European Indoor Air Quality Audit in 56 office buildings*, Indoor Air: 1996, 6(4), p-221-228

<sup>205</sup> European Commission Joint Research Centre IHCP (2014) *Harmonisation framework for health based evaluation of indoor emissions from construction products in the European Union using the EU-LCI concept*, Report No. 29.

<sup>206</sup> European Commission Joint Research Centre IHCP (2005) *Harmonisation of indoor material emissions labelling systems in the EU*, European Collaborative Action: Urban air, indoor environment and human exposure, Report No. 24.

<sup>207</sup> Eurofins, *France: Compulsory VOC emissions labelling*, <http://www.product-testing.eurofins.com/information/compliance-with-law/european-national-legislation/french-regulation-on-voc-emissions.aspx>

because of the emissions of naturally present resins. Best achievable practice for formaldehyde emissions from finished products is understood to be 40 µg/m<sup>3</sup>.

#### 2.5.3.2.2 Summary of feedback from the stakeholder written consultation

A stakeholder commented that the requirements are not strict enough, reflecting only the maximum requirements for formaldehyde in Germany. Moreover, the AgBB scheme in Germany sets a TVOC limit of 500 µg/m<sup>3</sup> after 28 days. Reference was also made to the proposed harmonised EU VOC classes 1 and 2 for construction products.

One stakeholder questioned the setting of the limits on TVOC and formaldehyde limits. The lack of health-based evidence and limitations associated with the test method CEN/TS 16516 were cited.

The comprehensive emissions limit for formaldehyde was considered by one stakeholder to be too strict and not likely to be achievable for wood-based floors. As EU LCI levels have not yet been set, it was not considered as appropriate to set this limit for EU GPP criteria.

Moreover, it was stressed that care should be taken that wood products are not unfairly discriminated by the criterion because they emit natural VOC compounds. It should be considered that wood may have other environmental and technical advantages compared to manufactured materials.

#### 2.5.3.2.3 Final criteria proposal

2.3.3.2.3 Final criteria proposal																																			
Core criteria	Comprehensive criteria																																		
TECHNICAL SPECIFICATIONS																																			
<p><b>D4. Selection of fit-out materials and finishes</b></p> <p>Each material and finish selected for the fit-out of the offices shall comply with the following emissions limits in table e below. This requirement shall apply to:</p> <ul style="list-style-type: none"><li>- Ceiling tiles</li><li>- Paints and varnishes</li><li>- Textile floor and wall coverings</li><li>- Laminate and flexible floor coverings</li><li>- Wooden floor coverings</li></ul> <p>All testing shall be on the as-finished product.</p> <p><i>Table e Materials and finishes emission limits</i></p> <table><tr><th rowspan="2">Product</th><th colspan="2">Emissions limits (µg/m³)</th></tr><tr><th>3 days</th><th>28 days</th></tr><tr><td>TVOCs</td><td>10,000</td><td>&lt;2,000</td></tr><tr><td>Formaldehyde</td><td>-</td><td>&lt;120</td></tr></table> <p><b>Verification:</b></p> <p>The main construction contractor or the DBO contractor shall provide compliant test results for each material or finish installed. The determination of emissions shall be in conformance with CEN/TS 16516, or equivalent product testing standards or labels which use the European 'reference room' as the basis for testing.</p>	Product	Emissions limits (µg/m³)		3 days	28 days	TVOCs	10,000	<2,000	Formaldehyde	-	<120	<p><b>D4. Selection of fit-out materials and finishes</b></p> <p>Each material and finish selected for the fit-out of the offices shall comply with the following emissions limits in table f below. This requirement shall apply to:</p> <ul style="list-style-type: none"><li>- Ceiling tiles</li><li>- Paints and varnishes</li><li>- Textile floor and wall coverings</li><li>- Laminate and flexible floor coverings</li><li>- Wooden floor coverings</li></ul> <p>All testing shall be on the as-finished product.</p> <p><i>Table f. Material and finishes emission limits</i></p> <table><tr><th rowspan="2">Product</th><th colspan="2">Emissions limits (µg/m³)</th></tr><tr><th>3 days</th><th>28 days</th></tr><tr><td>TVOCs</td><td>10,000</td><td>&lt;1,000</td></tr><tr><td>SVOCs</td><td>-</td><td>100</td></tr><tr><td>Formaldehyde</td><td>-</td><td>&lt;40</td></tr><tr><td>Carcinogens</td><td>&lt;10 sum</td><td>&lt;1 for each</td></tr><tr><td>- trichloroethylene,</td><td rowspan="4">total of the four substances</td><td rowspan="4">substance</td></tr><tr><td>- benzene</td></tr><tr><td>- DEHP</td></tr><tr><td>- DBP</td></tr></table> <p><b>Verification:</b></p> <p>The main construction contractor or the DBO contractor shall provide compliant test results for each material or finish installed. The determination of emissions shall be in conformance with CEN/TS 16516, or equivalent product testing standards or labels which use the European 'reference room' as the basis for testing.</p>	Product	Emissions limits (µg/m³)		3 days	28 days	TVOCs	10,000	<1,000	SVOCs	-	100	Formaldehyde	-	<40	Carcinogens	<10 sum	<1 for each	- trichloroethylene,	total of the four substances	substance	- benzene	- DEHP	- DBP
Product		Emissions limits (µg/m³)																																	
	3 days	28 days																																	
TVOCs	10,000	<2,000																																	
Formaldehyde	-	<120																																	
Product	Emissions limits (µg/m³)																																		
	3 days	28 days																																	
TVOCs	10,000	<1,000																																	
SVOCs	-	100																																	
Formaldehyde	-	<40																																	
Carcinogens	<10 sum	<1 for each																																	
- trichloroethylene,	total of the four substances	substance																																	
- benzene																																			
- DEHP																																			
- DBP																																			

#### Summary rationale:

- Emissions of Volatile Organic Compounds (VOC's) as well other hazardous substances of concern from construction products and interior finishes are a major area of focus for harmonisation work at EU level.
- Harmonised emissions levels for selected substances and compounds (LCI values) as well as a test method for determining emissions (CEN/TS 16516) have been published. A performance class system for reporting to consumers is still under development.
- A range of mature ecolabelling schemes for interior products exists in Scandinavia, Germany, Austria, France and the USA. These tend to combine substance specific LCI's with overall VOC and SVOC performance. The French scheme is mandated under national law.
- It is proposed that a technical specification is required reflecting the broad approach taken in current ecolabelling schemes for interior products, with the Core requirement focussing at a basic level on total VOC emissions and formaldehyde and the Comprehensive requirement introducing additionally SVOC's and four additional CMR (Carcinogenic, Mutagenic or toxic to reproduction) substances that are the subject of LCI values in the French national scheme.
- The performance for Core and Comprehensive are proposed to be aligned to 3<sup>rd</sup> and the 1<sup>st</sup> performance classes under the 2011 proposals for harmonised EU performance classes. These read across to the B and A+ classes in the French scheme, with the exception of formaldehyde for the limit value has been adjusted to reflect the best achievable values for wooden floor coverings.
- The harmonised test method described in CEN/TS 16516 is proposed for the verification.

### **2.5.3.3 Air quality testing**

#### **2.5.3.3.1 Background technical discussion and rationale**

In addition to the testing of hazardous emissions at a product level there are various examples of building assessment schemes that specify the measurement of the total emissions to which an occupier may be exposed to at a building level <sup>208</sup>. These include LEED (International), BREEAM (EU-wide) and DGNB (Germany and Austria). A summary of the approaches taken is provided in Table 2.18 below.

**Table 2.18: Summary comparison of post-occupancy testing of building Indoor Air Quality**

Building scheme	Time frame	Test specification	Test method
LEED (2013)	Post construction, but pre-occupancy.	<ul style="list-style-type: none"><li>- Formaldehyde</li><li>- Particulates (PM10 and 2.5)</li><li>- Ozone</li><li>- TVOC</li><li>- CO</li><li>- Specific target chemicals</li></ul>	ISO 16000-3 ISO 16000-6 ISO 7708 ISO 4224
BREEAM (2011)	Post construction, but pre-occupancy	<ul style="list-style-type: none"><li>- Formaldehyde</li><li>- TVOC</li></ul>	ISO 16000-3 ISO 16000-6 ISO 16017-2
DGNB (2008)	Maximum 4 weeks post-construction	<ul style="list-style-type: none"><li>- Formaldehyde</li><li>- TVOC</li></ul>	ISO 16000-3 ISO 16000-6 VDI 4300-6

Source: Eurofins (2013)

This form of testing is not mandatory in LEED and BREEAM, so is only likely to be chosen by the very best performing office buildings on the market. An indicative cost per test routine is €2,000 – €3,000 per building for two sample rooms and dependent on whether active or passive sampling is to be used. These costs would also need to be supplemented by any increased costs associated with the specification of low emission fit-out materials and products. The particulate element of the testing could be specified as an alternative to

<sup>208</sup> Eurofins, *Post construction air quality in sustainable building programmes*, <http://www.eurofins.com/product-testing-services/information/sustainable-buildings/indoor-air-quality-in-green-buildings/indoor-air-quality-by-program.aspx>

the proposed technical specification for fit-out materials and finishes and/or to cross-check that the proposed technical specification for ventilation results in lower exposure (see Section 2.4.3.2). The sampling of rooms for testing is most closely specified by DGNB, and so it is proposed to base the sampling requirements on their methodology.

In relation to threshold levels for possible health effects, ongoing research by JRC-IHCP and WHO guidelines provide a reference point. Evidence from JRC-IHCP suggests that TVOC's concentrations of greater than 1000 mg/m<sup>3</sup> may result in occupants suffering sensory irritation but that levels greater than 25,000 mg/m<sup>3</sup> would be required before significant health effects became a concern <sup>209</sup>. For formaldehyde WHO recommends thresholds of 0.1 mg/m<sup>3</sup> for sensory irritation and 1.25 mg/m<sup>3</sup> for cancer effects <sup>210</sup>. For particulates WHO recommends the following as thresholds <sup>211</sup>:

- PM2.5: 10 µg/m<sup>3</sup> annual average, 25 µg/m<sup>3</sup> 24-hour mean (no more than 3 days/year)
- PM10: 20 µg/m<sup>3</sup> annual average, 50 µg/m<sup>3</sup> 24-hour mean

The threshold levels used by the three building assessment schemes can be seen to be in line with or below the thresholds described above.

#### 2.5.3.3.2 Summary of feedback from the stakeholder written consultation

A number of stakeholders emphasised that it is important to test after the completion of works and before occupation, but another stakeholder also stressed that it is very difficult to carry out tests four weeks after completion because it could be a constraint on occupation of the building. It was suggested as being better to select more than one sample location in the building because there are several possible building configurations and indoor/outdoor conditions.

*These comments are addressed in the above-given background discussion and rationale.*

#### 2.5.3.3.3 Final criteria proposal

Core criteria	Comprehensive criteria						
<b>CONTRACT PERFORMANCE CLAUSES</b>							
	<p><b>F8. Air quality testing</b></p> <p>The lead contractor shall test the air quality within the building no more than four weeks following completion of the building fit-out with the materials and finishes in Criterion D5 and prior to occupation.</p> <p>Testing shall be carried out for each distinct room configuration in the building that accounts for &gt;10% of the office space. Two sample rooms with different façade aspects shall be tested per room configuration.</p> <p>The test results for each room specification tested in the building shall conform with the requirements in table g.</p> <p><i>Table g. Parameters for office air quality testing</i></p> <table> <tr> <th>Substance(s) to be tested</th><th>Testing parameters</th></tr> <tr> <td>Total Volatile Organic Compounds (TVOC's)</td><td>&lt;500 µg/m<sup>3</sup> (eight hour average) in accordance with ISO 16017-2 or equivalent</td></tr> <tr> <td>Formaldehyde</td><td>&lt;100 µg/m<sup>3</sup> (30 minutes average) in accordance with ISO 16000-3 or equivalent</td></tr> </table>	Substance(s) to be tested	Testing parameters	Total Volatile Organic Compounds (TVOC's)	<500 µg/m <sup>3</sup> (eight hour average) in accordance with ISO 16017-2 or equivalent	Formaldehyde	<100 µg/m <sup>3</sup> (30 minutes average) in accordance with ISO 16000-3 or equivalent
Substance(s) to be tested	Testing parameters						
Total Volatile Organic Compounds (TVOC's)	<500 µg/m <sup>3</sup> (eight hour average) in accordance with ISO 16017-2 or equivalent						
Formaldehyde	<100 µg/m <sup>3</sup> (30 minutes average) in accordance with ISO 16000-3 or equivalent						

<sup>209</sup> European Commission Joint Research Centre IHCP (1997) *Total Volatile Organic Compounds (TVOC's) in indoor air quality investigations*, European Collaborative Action: Urban air, indoor environment and human exposure, Report No. 19.

<sup>210</sup> WHO Europe (2010) *Selected pollutants: Guidelines for indoor air quality*.

<sup>211</sup> WHO Europe (2013) *Health effects of particulate matter*.



	Particulates	An eight hour average for two particle sizes in accordance with ISO 7708 or equivalent: PM10: 50 µ/m <sup>3</sup> PM2.5: 15 µ/m <sup>3</sup>
	The lead construction contractor or the DBO contractor shall carry out testing and provide test results demonstrating compliance with the required parameters. All measurements shall be taken during normal occupied hours and under design ventilation conditions in which the systems have been running for at least 12-24 hours prior to testing.	

Summary rationale:

- Three major building assessment schemes measure the total level of hazardous substances in the indoor air of an office building prior to occupation. Substances tested for include TVOC's, formaldehyde and particulates.
- Such a criteria is not currently mandatory and is not understood to be a general practice even in the most innovative building projects. However, it does offer a more rigorous check that indoor air quality has been improved as a result of product selection and ventilation design.
- It is proposed that a simplified test routine for TVOC, formaldehyde and particulates for a representative sample of office spaces is provided as an option for contracting authorities, as an alternative or in combination with the technical specification for fit-out materials and finishes.
- Such a criteria could be used either as an award criterion to encourage innovation in order to meet the emissions testing or as a contract performance clause to ensure that material and finish selection delivers improved indoor air quality.

#### **2.5.3.4 At what stage of the procurement process are the criteria relevant?**

The ventilation and air quality has been proposed as a technical specification (both for Core and Comprehensive criteria) to be applied during the detailed design and performance requirements procurement phase. The *design team* or the *DBO contractor* shall provide drawings and plans of the ventilation services detailing the air intake locations. These shall be provided at the detailed design stage and upon completion. They shall also obtain local air monitoring data from the local public authority enabling classification the location according to EN 13779 together with technical specifications for the air filter systems.

The selection of fit-out materials and finishes has been proposed as a technical specification (both for Core and Comprehensive criteria) to be applied during the construction of the building or major renovation works procurement phase. The main construction contractor or the DBO contractor shall provide compliant test results for each material or finish installed. The determination of emissions shall be in conformance with CEN/TS 16516 or equivalent product testing standards or labels, which use the European 'reference room' as the basis for testing.

Air quality testing has been proposed as a contract performance clause in comprehensive criterion to be applied during the practical completion and handover procurement phase. The *lead construction contractor* or the *DBO contractor* shall carry out testing and provide test results demonstrating compliance with the required parameters. All measurements shall be taken during normal occupied hours and under design ventilation conditions in which the systems have been running for at least 12-24 hours prior to testing.

The criteria classification, their reference numbers in the criteria document and the respective procurement phase can be cross-referenced as follows.

<b>Title of the criterion</b>	<b>Procurement phase</b>	<b>Criterion classification</b>	<b>Criteria typology</b>	<b>Reference number in the criteria document</b>
Ventilation and air quality	B. Detailed design and performance requirements	Core and Comprehensive	Technical specification	B7.3.
Selection of fit-out materials and finishes	D. Construction of the building or major renovation works	Core and Comprehensive	Technical specification	D5.
Air quality testing	F. Practical completion and handover	Comprehensive	Contract performance clause	F8.

## 2.6 Conclusions

For ease of/better readability of the document and to facilitate the cross reference with the GPP criteria document, the complete list of the GPP criteria with their classification and reference number in the criteria document is provided as follows.

Title of the criterion	Procurement phase	Criterion classification	Criteria typology	Reference number in the criteria document
<b>1. Energy related criteria</b>				
<b>1.1 Energy performance</b>				
Performance requirements: minimum energy performance				
Minimum Energy performance	B. Detailed design and performance requirements	Core and Comprehensive Core and Comprehensive	Technical specification Award criteria	B1. B8.
Installation and commissioning of building energy systems	D. Construction of the building or major renovation works	Core and Comprehensive	Technical specification	D2.
	F. Practical completion and handover	Core and Comprehensive	Contract performance clause	D5.
Quality of the completed building fabric	D. Construction of the building or major renovation works	Core and Comprehensive	Technical specification	F1.
	F. Practical completion and handover	Core and Comprehensive	Contract performance clause	F3.
<b>1.2 Lighting</b>				
Performance requirements: lighting control systems	B. Detailed design and performance requirements	Comprehensive	Technical specification	B2.
Commissioning and handover of lighting control systems				
<ul style="list-style-type: none"> <li>Installation and commissioning of building energy systems</li> </ul>	D. Construction of the building or major renovation works	Core and Comprehensive	Technical specification	D2.
<ul style="list-style-type: none"> <li>Lighting control systems</li> </ul>	F. Practical completion and handover	Comprehensive	Technical specification	F4.
<b>1.3 Building Energy Management System (BEMS)</b>				
Building energy management system	B. Detailed design and performance requirements	Core and Comprehensive	Technical specification	B3.
Commissioning and handover				
<ul style="list-style-type: none"> <li>Installation and commissioning of building energy systems</li> </ul>	D. Construction of the building or major renovation works	Core and Comprehensive	Technical specification	D2.
<ul style="list-style-type: none"> <li>Building energy management system</li> </ul>	F. Practical completion and handover	Core and Comprehensive	Technical specification	F5.
<b>1.4 Low or zero carbon energy sources</b>				
Performance requirements for energy supply systems				
<ul style="list-style-type: none"> <li>Low or zero carbon energy sources</li> </ul>	B. Detailed design and performance requirements	Core and Comprehensive Comprehensive	Technical specification Award criterion	B4. B9
Commissioning of energy supply systems				

<ul style="list-style-type: none"> <li>Installation and commissioning of building energy systems</li> </ul>	D. Construction of the building or major renovation works	Core and Comprehensive	Technical specification	D2.
	F. Practical completion and handover	Core and Comprehensive	Award criterion	F2.
Heating systems including Combined Heat and Power (CHP)	E. Installation of energy systems and the supply of energy services	Core and Comprehensive	Technical specification	E1.
Installation and commissioning of low or zero carbon energy sources	F. Practical completion and handover	Core and Comprehensive	Contract performance clause	F6.
<b>1.5 Facilities energy management</b>				
Building energy management system	G. Facilities management	Core and Comprehensive	Technical specification	G1.
Energy performance contract	G. Facilities management	Core and Comprehensive	Contract performance clause	G2.
	G. Facilities management	Core and Comprehensive	Contract performance clause	G4.
<b>2. Resources efficient construction</b>				
<b>2.1 Life cycle performance</b>				
Performance requirements of the main building elements	B. Detailed design and performance requirements	Core and Comprehensive	Award criterion	B10.1
<b>2.2 Recycled content</b>				
Incorporation of the recycled content <ul style="list-style-type: none"> <li>Incorporation of recycled content</li> <li>Monitoring the recycled content</li> </ul>	B. Detailed design and performance requirements	Core and Comprehensive	Award criterion	B10.2
	D. Construction of the building or major renovation works	Core and Comprehensive	Contract performance clauses	D6.
<b>2.3 Wood</b>				
Legal sourcing timber by the lead construction contractor	D. Construction of the building or major renovation works	Core and Comprehensive	Selection criterion	D1.
Legal sourcing of timber	D. Construction of the building or major renovation works	Core and Comprehensive	Contract performance clause	D7.
<b>2.4 Waste management plan</b>				
Demolition waste audit and management plan	C. Strip-out, demolition and site preparation works	Core and Comprehensive	Technical specifications	C1.
Site waste management plan	D. Construction of the building or major renovation works	Core and comprehensive	Technical specifications	D3.
Site waste management	D. Construction of the building or major renovation works	Core and comprehensive	Contract performance clauses	D8.
<b>3. Other environmental criteria</b>				
<b>3.1 Space/design of facilities</b>				
Performance requirements for recyclable waste storage <ul style="list-style-type: none"> <li>Performance requirements of recyclable waste storage</li> <li>Completion and handover of recyclable waste storage</li> </ul>	B. Detailed design and performance requirements	Core and Comprehensive	Technical specifications	B5.
	F. Practical completion and handover	Core and Comprehensive	Contract performance clauses	F7.
Waste management system	G. Facilities management	Core and Comprehensive	Technical specifications	G3.

	G. Facilities management	Core and Comprehensive	Contract performance clauses	G5.
<b>Water saving installations</b>				
Performance requirements of water saving installations	B. Detailed design and performance requirements	Core and Comprehensive	Technical specifications	B6.
<b>4. Quality of the office environment</b>				
<b>4.1 Thermal comfort conditions</b>	B. Detailed design and performance requirements	Core and Comprehensive	Technical specification	B7.1.
<b>4.2 Daylighting and glare</b>	B. Detailed design and performance requirements	Core and Comprehensive	Technical specification	B7.2.
<b>4.3 Air quality</b>				
Ventilation and air quality	B. Detailed design and performance requirements	Core and Comprehensive	Technical specification	B7.3.
Selection of fit-out materials and finishes	D. Construction of the building or major renovation works	Core and Comprehensive	Technical specification	D4.
Air quality testing	F. Practical completion and handover	Comprehensive	Contract performance clause	F8.
<b>5. Competencies of the design team and contractors</b>				
<b>5.1 Competencies of the project manager and the design team</b>	A. Selection of the design team and contractors	Core and Comprehensive	Selection criteria	A1.
<b>5.2 Competencies of the lead construction contractor, specialist contractors and/or property developers</b>	A. Selection of the design team and contractors	Core and Comprehensive	Selection criteria	A2.

The possible chronological order of the GPP criteria is shown in the following table.

Core criteria	Comprehensive criteria
<b>A. Selection of the design team and contractors</b>	
<b>SELECTION CRITERIA</b>	
A1. Competencies of the project manager and design team	A1. Competencies of the project manager and design team
A2. Competencies of the lead construction contractor, specialist contractors and/or property developers	A2. Competencies of the lead construction contractor, specialist contractors and/or property developers
<b>B. Detailed design and performance requirements</b>	
<b>TECHNICAL SPECIFICATIONS</b>	
B1. Minimum Energy performance	B1. Minimum Energy performance
B2. Lighting control systems	B2. Lighting control systems
B3. Building energy management system	B3. Building energy management system
B4. Low or zero carbon energy sources	B4. Low or zero carbon energy sources
B5. Recyclable waste storage	B5. Recyclable waste storage
B6. Water saving installations	B6. Water saving installations
B7.1 Thermal comfort conditions	B7.1 Thermal comfort conditions
B7.2 Daylighting and glare	B7.2 Daylighting and glare.
B7.3 Ventilation and air quality	B7.3 Ventilation and air quality
<b>AWARD CRITERIA</b>	
B8. Minimum Energy performance	B8. Minimum Energy performance
	B9. Low or zero carbon energy sources
B10.1 Performance of the main building elements	B10.1 Performance of the main building elements
B10.2 Incorporation of recycled content	B10.2 Incorporation of recycled or re-used content
<b>C. Strip-out, demolition and site preparation works</b>	
<b>TECHNICAL SPECIFICATIONS</b>	
C1. Demolition waste audit and management plan	C1. Demolition waste audit and management plan
<b>D. Construction of the building or major renovation works</b>	

<b>SELECTION CRITERIA</b>	
D1. Legal sourcing of timber by the lead construction contractor	D1. Legal sourcing of timber by the lead construction contractor
<b>TECHNICAL SPECIFICATIONS</b>	
D2. Installation and commissioning of building energy systems	D2. Installation and commissioning of building energy systems
D3. Site waste management	D3. Site waste management
D4. Selection of fit-out materials and finishes	D4. Selection of fit-out materials and finishes
<b>CONTRACT PERFORMANCE CLAUSE</b>	
D5. Installation and commissioning of building energy systems	D6. Installation and commissioning of building energy systems
D6. Incorporation of recycled content	D6. Incorporation of recycled or reused content
D7. Legal sourcing of timber	D7. Legal sourcing of timber
D8. Site waste management	D8. Site waste management
<b>E. Installation of energy systems and the supply of energy services</b>	
<b>TECHNICAL SPECIFICATIONS</b>	
E1. Heating systems, including Combined Heat and Power (CHP)	E1. Heating systems, including Combined Heat and Power (CHP)
<b>F. Practical completion and handover</b>	
<b>TECHNICAL SPECIFICATIONS</b>	
F1. Quality of the completed building fabric	F1. Quality of the completed building fabric
<b>AWARD CRITERIA</b>	
F2. Installation and commissioning of low or zero carbon energy sources	F2. Installation and commissioning of low or zero carbon energy sources
<b>CONTRACT PERFORMANCE CLAUSES</b>	
F3. Quality of the completed building fabric	F3. Quality of the completed building fabric
F4. Lighting control systems	F4. Lighting control systems
F5. Building energy management system	F5. Building energy management system
F6. Installation and commissioning of low or zero carbon energy sources	F6. Installation and commissioning of low or zero carbon energy sources
F7. Recyclable waste storage	F7. Recyclable waste storage
	F8. Air quality testing
<b>G. Facilities management</b>	
<b>TECHNICAL SPECIFICATIONS</b>	
G1. Building energy management system	G1. Building energy management system
G2. Energy performance contract	G2. Energy performance contract
G3. Waste management system	G3. Waste management system
<b>CONTRACT PERFORMANCE CLAUSE</b>	
G4. Energy performance contract	G4. Energy performance contract
G5. Waste management system	G5. Waste management system
<b>PROPOSED TECHNICAL ANNEXES</b>	
Annex 1 - Supporting guidance for criterion B10.1: Option 1 - Aggregation of EPDs	
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## 3 Life cycle costing

### 3.1 Introduction to Life Cycle Costing (LCC)

LCC analysis is a method for assessing the total cost of the product group. It takes into account all costs of acquiring, owning, and disposing of a building. The purpose of an LCC is to estimate the overall costs of project alternatives and to select the design that ensures the facility will provide the lowest overall cost consistent with its quality and function. The LCC should be performed early in the design process.

There are numerous costs associated with acquiring, operating, maintaining, and disposing of a building or building system. Building-related costs usually fall into the following categories:

- *Initial Costs:* Initial costs may include capital investment costs for land acquisition, construction, or renovation and for the equipment needed to operate a facility. Land acquisition costs need to be included in the initial cost estimate if they differ among design alternatives.
- *Fuel Costs:* Operational expenses for energy, water, and other utilities are based on consumption, current rates, and price projections. Because energy, and to some extent water consumption, and building configuration and building envelope are interdependent, energy and water costs are usually assessed for the building as a whole rather than for individual building systems or components. Energy costs are often difficult to predict accurately in the design phase of a project. Assumptions about use profiles, occupancy rates, and schedules impact on energy consumption. At the design stage, data on the amount of energy consumption for a building can be derived from a dynamic simulation model. Quotes for current energy prices from local suppliers should take into account the rate type, the rate structure, summer and winter differentials, block rates, and demand charges in order to obtain an estimate as close as possible to the actual energy cost. The energy prices are assumed to increase or decrease at a rate different from general price inflation. This differential energy price escalation needs to be taken into account when estimating future energy costs.
- *Operation, Maintenance, and Repair Costs (OM&R):* Non-fuel operating costs, and OM&R costs are often more difficult to estimate than other building expenditures.
- *Replacement Costs:* The number and timing of capital replacements of building systems depend on the estimated life of the system and the length of the study period. Usually, the same sources that provide cost estimates for initial investments are used to obtain estimates of replacement costs and expected useful lives.
- *Residual Values:* the residual value of a system (or component) is its remaining value at the end of the study period (50 years), or at the time it is replaced during the study period. As a rule of thumb, the residual value of a system with remaining useful life in place can be calculated by linearly prorating its initial costs.
- *Finance Charges—Loan Interest Payments:* For public projects, finance charges are usually not relevant but may be relevant for public/private arrangements.

Only those costs within each category that are relevant to the decision and are of a significant amount are needed in order to make a valid investment decision. All costs are entered as base-year amounts in today's euro; the LCCA method escalates all amounts to their future year of occurrence and discounts them back to the base date to convert them to present values.

Moreover, several parameters for a Net Present-Value Analysis should also be considered. These parameters are mainly:

- *Discount Rate:* In order to be able to add and compare cash flows that are incurred at different times during the life cycle of a project, they have to be made time-equivalent. The interest rate used for discounting is a rate that reflects an investor's opportunity cost of money over time, meaning that an investor wants to achieve a return at least as high as that of her next best investment. Hence, the discount rate represents the investor's minimum acceptable rate of return.
- *Length of investment period:* The investment period begins with the base date, the date to which all cash flows are discounted. The study period includes any planning/construction/implementation period and the service or occupancy period. The study period is the same for all alternatives considered.

• *Service period*: The service period begins when the completed office building is occupied. This is the period over which operational costs and benefits are evaluated.

• *Treatment of Inflation*: An LCC can be performed in constant euro or current euro. Constant-euro analyses exclude the rate of general inflation, and current-euro analyses includes the rate of general inflation in all euro amounts, discount rates, and price escalation rates. Both types of calculation result in identical present-value life-cycle costs.

*Constant-euro* analysis is recommended for all public projects. The constant-euro method has the advantage of not requiring an estimate of the rate of inflation for the years in the study period. Alternative financing studies are usually performed in current euro's if the analyst wants to compare contract payments with actual operational or energy cost savings from year to year.

The LCC calculation is carried out after identifying all costs by year and amount and discounting them to present value, they are added to arrive at total life-cycle costs for each alternative:

$$\text{LCC} = I + \text{Repl} - \text{Res} + E + W + \text{OM\&R} + O$$

**LCC** = Total LCC in present-value (PV) euro of a given alternative

**I** = PV investment costs (if incurred at base date, they need not be discounted)

**Repl** = PV capital replacement costs

**Res** = PV residual value (resale value, salvage value) less disposal costs

**E** = PV of energy costs

**W** = PV of water costs

**OM&R** = PV of non-fuel operating, maintenance and repair costs

**O** = PV of other costs (e.g., contract costs for ESPCs or UESCs)

Supplementary measures of economic evaluation are Net Savings (NS)<sup>212</sup>, Savings-to-Investment Ratio (SIR)<sup>213</sup>, Adjusted Internal Rate of Return (AIRR)<sup>214</sup>, and Simple Payback (SPB)<sup>215</sup> or Discounted Payback (DPB)<sup>216</sup>. NS, SIR, and AIRR are consistent with the lowest LCC of an alternative if computed and applied correctly, with the same time-adjusted input values and assumptions. Payback measures, either SPB or DPB, are only consistent with LCCA if they are calculated over the entire study period, not only for the years of the payback period. All supplementary measures are relative measures, i.e., they are computed for an alternative relative to a base case.

Decisions about building-related investments typically involve a great deal of uncertainty about their costs and potential savings. Performing an LCC greatly increases the likelihood of choosing a project that saves money in the long run. Yet, there may still be some uncertainty associated with the LCC results.

## 3.2 Findings from an LCC analysis of an example base-case

In the preliminary background study a life cycle cost assessment was carried out for a base-case office building defined as an example. This LCC exercise demonstrated that it is important not to consider investment cost in isolation, but instead the life cycle cost including energy and water use over the product's life. The LCC approach allows public bodies to explore the costs and benefits of different office building not just according to their investment costs but also their operational cost. The calculations above show that the costs of energy, especially those of electricity dominate the LCCs for office buildings.

### *Lighting and control systems*

<sup>212</sup> NS = Net Savings: operational savings less difference in capital investment costs NS > 0 (for determining cost-effectiveness)

<sup>213</sup> SIR = Savings-to-Investment Ratio: ratio of operational savings to difference in capital investment costs. SIR > 1 (for ranking projects)

<sup>214</sup> AIRR = Adjusted Internal Rate of Return: annual yield from an alternative over the study period, taking into account reinvestment of interim returns at the discount rate. AIRR > discount rate (for ranking projects)

<sup>215</sup> SPB = Simple Payback: time required for the cumulative savings from an alternative to recover its initial investment cost and other accrued costs, without taking into account the time value of money

<sup>216</sup> DPB = Discounted Payback: time required for the cumulative savings from an alternative to recover its initial investment cost and other accrued costs, taking into account the time value of money  
SPB, DPB < than study period (for screening projects)



The assessment shows that just by changing energy consumption in lighting, and keeping all other aspects equal, savings ranging from 17,800€ to 13,000€ euros can be achieved per office building for the base-case examples over their lifetime. Even if investment costs were 4 times higher across all examples, the savings in each case would still exceed the increase in investment cost.

If an office building has additional lighting control systems, the life cycle costs can be expected to drop even further, as electricity for lighting forms the most cost-intensive factor along the product life cycle (nevertheless, the calculation of this saving is difficult due to the variability of daylighting depending on the location and design of the building under study). Moreover, it is clear that given the large possible variation in designs, functions, investments and use patterns across Europe, the inputs for the LCC assessment will need to be considered by purchase authorities on a case by case basis.

#### *Window specifications*

The greatest financial savings in heating and cooling can be made through the improvement of windows. This aspect is of especial importance for office buildings located in middle to colder climatic zones. The investment strategies should therefore be developed to specify lower U-value windows, such as double and triple glazing windows, in order to minimise the life cycle costs of office building. Improved insulation of external walls can provide further savings but it strongly depends on the location and design of the office building, as external cladding systems can have very substantial capital costs.

#### *Insulation levels*

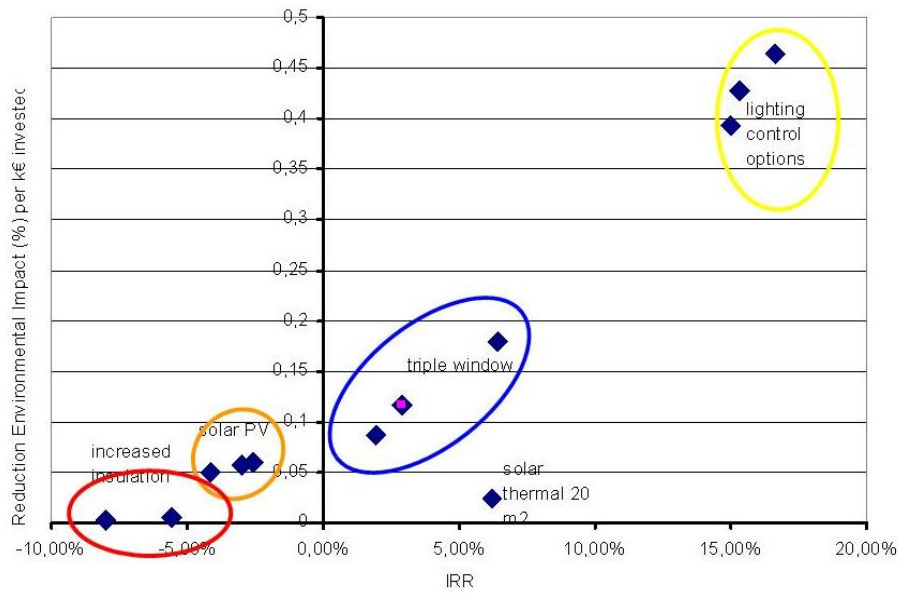
Increasing the insulation levels on existing buildings, which generally have poor insulation, is a measure which can provide large energy savings, particularly related to the reduction on space heating demand. The costs of this measure in existing buildings are relatively large, as besides the insulation material costs; there are also other related costs, such as those related to labour and equipment to access the building facades or internal walls, significantly increased the overall investment cost of the insulation technique used. However, if the insulation works are carried out together within an integral refurbishment strategy, as it is usually the case, the costs allocated for the insulation could be diminished. If this is the case, the estimated costs for the insulation and the IRR values presented in the chart change significantly, obtaining better values.

The savings that can be achieved by using the above mentioned measures depend on the use pattern for offices in public buildings, for example an office building devoted to bureaucratic work such as that of a ministerial office building or a council building compared to an office building devoted to post services, where storage facilities, reception desks/counters and other kind of facilities must be close to the employees desks. The expected use will need to be considered carefully by the purchasing authority in order to calculate the LCC accurately.

The installation, repair and maintenance costs used in the above analysis are not considered. Depending on the type of installations, the function of the office building or level of repair and maintenance these costs will vary case by case. Nevertheless, repair and maintenance costs are likely to be relatively low in the overall life cycle costs. Likewise installation replacement cost of some buildings elements is neither considered. These costs such as the replacement costs of windows or external doors will depend on whether it is part of larger refurbishment work or not so large.

A comparison of the proposed improvement measures from the environmental and financial points of view was carried out. The comparison was based on the percentage of reduction of the environmental impact per thousand euro invested and its internal rate of return (IRR). Figure 3.1 shows the results for the base cases located in London. Those measures, whose ratios are in the upper-right corner, such as lighting control options or triple glazing windows are highly beneficial from both economic and environmental perspective.

Improvement measures which have larger associated costs compared to the environmental savings would appear lower in the graphic and to the left if the investment is not recovered. This is the case of the increased insulation when the investment costs should be entirely recovered by the energy savings. However, when a major renovation is decided, mainly due to other reasons such as a new layout of the offices, the investment needed is much lower and consequently the ratios shift toward the upper-right part of the chart.



**Figure 3.1: Comparison of the percentage of reduction of the environmental impact per thousand euro invested and its internal rate of return (IRR) for several improvement measures analysed in this section,**

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