
Guidance for low-carbon building projects and estates management

Procurement requirements for carbon efficiency



Model procurement wording for delivering carbon efficiency in
new and existing buildings

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Summary

This guide will help you to set requirements for “carbon efficiency” (or low-carbon buildings) when procuring design, construction, refurbishment and facilities management (FM) services for existing and new buildings. It provides:

- guidance on what to ask for (metrics, outcomes, reporting etc); and
- model wording which you can include in your PQOs, Invitations to Tender, contracts and other documents.

You can use procurement as a lever to cut energy costs, demonstrate corporate responsibility and obtain the data you need for carbon management (e.g. under the CRC Energy Efficiency Scheme or BREEAM).

The proposed approach centres on requiring a “Carbon Efficiency Plan” (similar to an energy management plan) from an early stage. This provides:

- a framework for robust forecasting, measurement and reporting;
- a systematic focus on the most cost-effective actions at each stage of project/service delivery; and
- a mechanism for communicating specific plans, responsibilities and data between multiple parties (client, designer, build/FM contractor, subcontractors, occupiers etc).

Embodied carbon (i.e. the emissions associated with providing building materials) is an increasingly significant fraction of total carbon impact. The model requirements include a simple option for reducing embodied carbon in advance of consensus emerging on European standards and more complex whole-project carbon footprinting. The WRAP Information Sheet for construction clients and designers: “Cutting embodied carbon in construction projects” provides advice on cost-effective actions to achieve this^{Error! Bookmark not defined.}.

The core elements of the proposed clauses are set out below.

Core elements for new build and major refurbishment

The following requirements should be included in the project brief, invitation to tender and contract documents for consultant and contractor appointments:

1. *develop and implement a Carbon Efficiency Plan (or equivalent) from an early design stage, to include:*
 - *a forecast for operational energy and associated carbon emissions (including regulated and unregulated emissions);*
 - *a cost-effective project-specific target which meets or exceeds regulatory requirements;*
 - *the key design parameters by which the target will be achieved, including accepted performance tolerances and verification procedures; and*
 - *actions to be taken in design, equipment specification, construction, commissioning and early occupancy to reduce carbon emissions and ensure effective implementation – with clearly identified responsibilities of relevant parties.*
2. *provide the Carbon Efficiency Plan to the client [optionally – together with supporting calculations and energy/carbon models] within design stage reports and on completion of the project, reporting predicted performance of the design and of the as-built installation.*

The client should require their consultants and contractors to:

3. *achieve a minimum design outcome for predicted operational carbon emissions at building level [for example]:*
 - *an EPC (Energy Performance Certificate) rating of [x] for regulated emissions;*
 - *a reduction of [x] % beyond the Target Emission Rate required by Building Regulations 2010;*
 - *a predicted DEC (Display Energy Certificate) rating of [y] for regulated and unregulated emissions; or*
 - *annual emissions of no more than [x] kg CO₂e per occupant / visitor / full time equivalent employee or per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area.*

4. [where applicable] *achieve the credits for operational carbon emissions [and embodied carbon] required to meet a BREEAM / LEED / Code for Sustainable Homes rating of [x] (or equivalent).*

Optionally, the client may require their consultants and contractors to reduce embodied carbon:

5. *identify the [5-10] most significant cost-effective opportunities to reduce the embodied carbon emissions associated with the project (e.g. through leaner design, designing out waste, reusing materials, and selecting materials with lower embodied carbon over the project life-cycle), quantify the savings made through individual design changes, and report actions and outcomes as part of the Carbon Efficiency Plan.*

The client should explicitly ask their technical advisor to (a) identify the most significant operational [and embodied] carbon impacts of the building, (b) define project-specific targets for operational carbon efficiency [and savings in embodied carbon], taking into account corporate and regulatory requirements, potential outcomes and cost-effectiveness, and (c) evaluate and report progress against targets over the course of the project.

http://www.wrap.org.uk/downloads/FINAL_PRO095-009_Embodied_Carbon_Annex.54477088.10637.pdf

Core elements for buildings in use

The following requirements should be included in the service specification, invitation to tender and contract documents for asset and facilities manager appointments:

1. *develop and/or implement a Carbon Efficiency Plan (or equivalent), to include:*

- *a forecast for operational energy and associated carbon emissions;*
- *a target for operational energy and associated carbon emissions;*
- *management actions and investment priorities for reducing cost and improving carbon efficiency.*

The client should require their asset manager to:

2. *take steps to meet or exceed the operational target for the building of [delete as appropriate]:*
 - *annual energy consumption of [x] kWh per occupant / visitor / full time equivalent employee or per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area;*
 - *annual carbon emissions of [x] kg CO₂e per occupant / visitor / full time equivalent employee or per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area;*
 - *a DEC (Display Energy Certificate) rating of [x]; and/or*
 - *a [x] % reduction in energy / carbon emissions relative to performance in 20[xx].*

The client should require their facilities manager to:

3. *measure and report performance on a periodic (e.g. quarterly) basis or as required to meet legal (e.g. CRC Energy Efficiency Scheme) and other reporting requirements. Reports should be supported by evidence in the form of utility bills and should present:*
 - *the energy consumption in kWh split by fuel source for the areas for which the facilities manager has responsibility;*
 - *the carbon emissions associated with this energy consumption based on the carbon conversion factors published by DECC (Department of Energy and Climate Change) for use in CRC reporting;*
 - *the floor area / occupants / visitors / full time equivalent employees for the areas to which the facilities management contract applies; and*
 - *overall energy and carbon efficiency in the form of annual kWh and kg CO₂e per occupant / visitor / full time equivalent employee or per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area.*
4. *provide the business case for any actions to reduce carbon emissions – based on the estimated capital and lifecycle costs of the recommended works, the value of reduced carbon emissions and the allocation of costs*

and benefits between parties.

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1.0 Introduction

This guide will help you to set requirements for carbon efficiency when procuring design, construction, refurbishment and facilities management services for existing and new buildings. It provides model wording for each stage of the procurement process, and is primarily aimed at construction clients, property owners, building managers and their advisers. The guide will also be of use to design teams, contractors and facilities managers, e.g. when appointing their supply chains.

A wide range of regulations, standards and guidance exist in relation to operational energy use and carbon emissions. The framework of requirements provided in this guide will help you bring a more effective and consistent approach to an existing project objective. The approach also fits within broader systems for environmental management.

Buildings are responsible for around half of UK carbon emissions. Consequently, reducing these emissions is the objective of various Government¹ policy measures. You can use tender and contract clauses to meet and exceed policy requirements – with the aim of cutting energy costs, demonstrating corporate responsibility and policy compliance, competing with your peers, obtaining robust data, and preparing for future energy risks.

The model procurement wording is available in an interactive format at:
www.wrap.org.uk/carbonefficientprocurement.

Contracting authorities must make sure that their procurement exercises are consistent with the EU Treaty and the EU Public Procurement Directives, which are implemented into UK law through the Public Contracts Regulations 2006 (SI 2006/5) (the “Regulations”). Treaty principles apply to all public procurement activity, and procurement exercises above certain financial thresholds must comply with the rules laid down in the Directives and Regulations.

1.1 What are you trying to influence?

To reduce the carbon impact of your buildings, you need to initiate some critical actions:

- set a clear policy and target on carbon efficiency;
- define (or get your technical advisers to define) simple clear outcomes for design, construction, refurbishment and buildings management to include in the contract specification;
- ensure your design team takes a systematic approach to “designing-in” carbon efficiency, focusing on the most cost-effective solutions (e.g. passive design, not just low-energy technologies);
- define robust metrics, KPIs and reporting requirements, and make clear who is responsible for carbon efficiency at each stage of the building life-cycle;
- require a process to ensure that “in-use” carbon outcomes meet the design specification; and
- mandate your facilities manager to monitor performance and identify cost-effective actions for maintenance, retrofit, refurbishment and influencing occupant behaviour.

You can achieve these objectives by setting some simple requirements in your project brief, tender invitation and contract documents (alongside requirements for water efficiency, waste reduction etc).

For existing buildings, the majority of carbon savings will come from reducing operational carbon, particularly via energy consumption but, for new buildings, consider also asking for savings in embodied carbon (see Box 1). As buildings get more energy efficient, embodied carbon will become an increasingly large percentage² of the overall carbon impact of a building over its life-cycle. For infrastructure projects, embodied carbon may be the major carbon impact. Since embodied carbon is not widely understood, and standards for its measurement are still under development, consider identifying a project where you can pilot its evaluation – to begin with, focus your time and effort on the key elements where embodied carbon is known and you can make big savings, rather than conducting a comprehensive assessment of every aspect.

¹ In this document, references to Government policy generally refer to policy measures in England.

² Embodied carbon may exceed 50% of life-cycle carbon emissions associated with a building as policy measures push towards “zero-carbon buildings”.

It is important to think holistically and consider the total carbon impact of a building. Figure 1 illustrates a structured approach to such decisions.

Box 1: Definitions of embodied and operational carbon

Embodied carbon refers to the carbon emissions (CO₂e) embodied in:

- the extraction, manufacture and transportation of construction products to site; and
- the end-of-life recovery, treatment and disposal of construction products.

Operational carbon refers to the carbon emissions (CO₂e) associated with:

- direct emissions from stationary onsite combustion of fuels for normal building operations; and
- indirect emissions from the production of electricity consumed for normal building operations³.

Note that CO₂e (encompassing the range of greenhouse gases) is the preferred metric as it is included in industry standards. However, where CO₂e data are not available, CO₂ can be used instead. The difference for embodied carbon is around 5-10% at building level.

See Appendix 2 for more detailed information on embodied carbon. Appendix 3 illustrates the elements that comprise both embodied and operational carbon.

³ The Greenhouse Gas Protocol further categorises direct and indirect emissions into three broad scopes: Scope 1 – all direct emissions; Scope 2 – indirect emissions from consumption of purchased electricity, heat or steam; and Scope 3 – other indirect emissions. <http://www.ghgprotocol.org/calculation-tools/faq>



Figure 1: Hierarchy of decision-making for new build

A proactive approach to carbon efficiency should include design and specification, management and behaviour. New buildings present an important opportunity to 'design in' carbon efficiency and reduce embodied carbon. Improving the performance of existing buildings can deliver operational carbon savings with no or minimal increase in embodied carbon.

You can also set requirements for carbon efficiency in the actual construction process⁴. The Strategic Forum for Construction's Construction Commitments set a target for the industry to reduce carbon emissions in construction by 15% by 2012. The procurement requirements in this guide will help contractors fulfil this objective.

⁴ Contracting authorities subject to the Regulations must ensure that tender evaluation criteria are relevant to the subject matter of the contract. For more information on industry actions to reduce carbon emissions associated with the construction process, see the work of the Strategic Forum for Construction (<http://www.strategicforum.org.uk/carbon.shtml>).

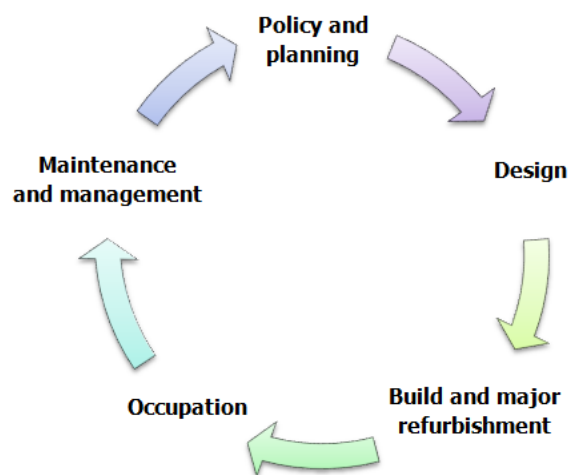


Figure 2: Life-cycle stages for a carbon-efficient building

Section 2 of this guide provides information on the proposed approach to procurement for carbon efficiency. The guide is then divided into sections, each covering a stage of the building life cycle as shown in the diagram above, so you can refer to the section that is relevant for you:

Section 3	Policy and planning
Section 4	Design
Section 5	Build and major refurbishment
Section 6	Occupation
Section 7	Maintenance and management

Sections 3 to 7 provide model wording to help incorporate requirements into policy, pre-qualification, briefing, tender and appointment documents.

Effective communication between the developer/owner, occupiers, designers and contractors is essential if a building is to achieve its potential for carbon efficiency. A key aspect of the approach proposed in this guidance is the use of a 'Carbon Efficiency Plan' or equivalent. The Carbon Efficiency Plan provides a mechanism for transfer of information by clearly stating current or predicted performance, targets for improvement, commercially viable actions by which these will be achieved and a programme for implementation (See Section 1.3 for more detail). A Carbon Efficiency Plan can provide a robust method of delivering a cost-effective, low carbon building, taking into account the whole life-cycle of the building.

1.2 Why take action on carbon efficiency?

Carbon is becoming a major influence on corporate decision-making. Reputation, energy costs and energy security remain significant factors, but as the Government implements policies to deliver its legally-binding carbon reduction targets⁵, taking action to reduce emissions and use low carbon energy is increasingly relevant to an organisation's financial performance and value.

⁵ The UK adopted the Climate Change Act 2008 in November 2008 which sets targets for the UK to achieve an 18% reduction in carbon emissions by 2020 on 2008 levels (a 34% reduction on 1990 levels), and generate at least 20% of UK energy requirements from renewable sources. Buildings account for 40-50% of the UK's energy consumption, therefore design, construction and operation of buildings is key to reaching this target.

The policy trajectory towards zero carbon buildings will ensure regulations continue to provide a challenge for new buildings, whilst the growing investor and occupier interest in the environmental performance of buildings, along with penalty and incentive mechanisms such as CRC Energy Efficiency Scheme, will continue to drive existing buildings toward carbon efficiency.

Drivers can be grouped into four broad areas: cost savings; increasing regulatory requirements; financial penalties and incentives; and greater performance expectations from influential stakeholders.

1.2.1 Cost savings

It is typically possible to make major reductions in energy consumption and operating costs through the use of efficient technologies and importantly through monitoring and management of performance. For new buildings, design changes can provide significant cost savings over the life of the asset. For existing buildings, the energy or facilities manager will be able to identify improvements that, although requiring capital investment, should pay back within 5 years or less⁶. The costs and benefits of different systems will vary depending on the characteristics of the building and it is therefore important to assess the capital and lifecycle costs and savings from any investment. Where an option presents a positive cost benefit, consideration must be given to the distribution of costs and benefits between landlord and occupier to enable effective negotiation between all parties as to how investment should be financed and costs recovered. However, since energy costs may be only a small % of total occupancy costs, it is not always easy to get carbon savings on the agenda.

1.2.2 Regulation

Part L of English Building Regulations has been significantly overhauled in 2010. As well as tightening the performance standards for new buildings, the new regulations require project teams to consider the 'passive' performance of new non-domestic buildings by preventing excessive heat gain from the sun. These requirements will force design teams to consider the underlying efficiency of their buildings rather than simply relying on technological fixes to maintain a comfortable internal environment. The 2010 regulations are the latest step in a progressive tightening of performance standards which will culminate in new buildings needing to achieve Zero Carbon status between 2016 and 2019⁷.

Planning policy also remains a powerful influence on the performance of new buildings. Over half of UK local authorities have planning requirements requiring the use of renewable energy in new development [where is this statistic from?], with many councils also asking for minimum performance ratings against assessment methods such as BREEAM and the Code for Sustainable Homes.

1.2.3 Penalties and incentives

Feed-in Tariffs which became available in Great Britain on 1 April 2010 provide a direct financial benefit for organisations which generate electricity from renewable or low carbon sources. Qualifying technologies include photovoltaics, wind turbines, micro combined heat and power and hydroelectricity. Payments are linked to the size and type of technology installed, and are guaranteed for between 10 and 25 years depending on technology. In addition to the tariff, generators get a guaranteed income of 3p per kWh for all energy sold into the grid. Tariff revenues have been designed to give returns of around 7-9% – and these revenues are relatively low risk with tariff levels and export payments guaranteed and inflation-linked for a defined period.

For existing buildings, the CRC Energy Efficiency Scheme (CRC EES) is a major new initiative aimed at incentivising carbon reductions in medium to large sized energy users that are not covered by the European Union Emissions Trading Scheme. The CRC EES requires organisations that directly procure above 6,000 kWh of

⁶ Research conducted by the Investment Property Forum identifies that many investment opportunities for both vacant and occupied buildings have payback periods of under 3 years, including: use of variable speed pumps; installation of fan coil units with DC drives; high efficiency lighting and controls; use of a thermal wheel for heat recovery; and installation of high efficiency boilers and/or chillers.

⁷ New buildings should achieve the zero carbon standard by 2016 (for domestic buildings), 2018 (for schools and other public buildings) and 2019 (for other non-domestic buildings).

electricity per year to purchase allowances to cover the carbon emissions associated with their energy consumption. A further major impact of the CRC EES will be a greater emphasis on effective data management to ensure that accurate data on energy consumption are gathered together with supporting evidence. The CRC EES will therefore reward organisations able to deliver reductions in emissions through improved efficiency.

1.2.4 Stakeholder expectations

Investors and occupiers are increasingly interested in the environmental performance of the buildings that they own or occupy. Corporate responsibility schemes such as the Global Reporting Initiative Index, the FTSE4Good Index and the Carbon Disclosure Project set high standards for carbon efficiency disclosure. The commercial significance of reporting data publicly has driven the development of consistent metrics for carbon emissions and definitions for how it should be measured and reported.

Indicators, labelling and rating schemes are now in place to help organisations define their carbon performance – a number of which are mandatory in certain situations. For example, Energy Performance Certificates (EPC) provide a design benchmark on energy and carbon associated with 'regulated' emissions, Display Energy Certificates (DEC) report on the actual energy and carbon emissions from an operational building, and BREEAM / LEED / Code for Sustainable Homes ratings provide whole building assessment methods that award a specific rating based on meeting verified design standards. Initiatives such as CEN TC350 are also working to provide consistent data on embodied carbon associated with construction materials.

1.3 Role of a Carbon Efficiency Plan

A Carbon Efficiency Plan (CEP) or equivalent should be a central tool for reducing the carbon impact of new and existing buildings. Delivery of carbon/cost savings requires many parties to take coordinated actions (designers, major contractor, subcontractors, asset manager etc) – the CEP provides a framework for ensuring effective interfacing between these parties.

A Carbon Efficiency Plan (for a new or existing building) should contain the following information:

Key elements of a Carbon Efficiency Plan:

- description of the project/building, its current or projected occupancy, details of energy meters, installation of energy-consuming fittings and appliances and their current or likely usage;
- the client/project **objective or requirement** (e.g. maximum carbon emissions, or corporate target for improvement), which may have been defined in the Project Brief and/or contract;
- **design estimates of carbon emissions**⁸ [and, if targeted, embodied carbon emissions] arising from alternative design specifications (estimates should be both overall and on a per person or per m² basis);
- **projected financial, carbon and energy savings** and associated financial costs from going beyond the minimum requirement for the project [and, if appropriate, the contribution to meeting the project's target environmental rating for BREEAM or the Code for Sustainable Homes];
- **a project-specific target** for carbon emissions (design estimate or in-use) that meets or exceeds the requirement set for the project – and supporting justification on the basis of cost, acceptability or other relevant criteria;
- **specific cost-effective actions**, supported by justification for their selection, to:
 - achieve the carbon emissions target by minimising consumption or using low-carbon energy;
 - enable monitoring of energy use (e.g. additional sub-metering or a building management system);
 - ensure effective commissioning during handover and occupation;
 - influence user behaviour through design and building management; and

⁸ Consumption of energy loads regulated by Part L should be estimated using the approved methodology. For dwellings, use the Standard Assessment Procedure (SAP) for Energy Rating of Dwellings (www.bre.co.uk/sap2009). For non-dwellings, use the National Calculation Method (www.2010ncm.bre.co.uk).

- ensure effective operation of the system over time.
- **a data log of designed-in and actual energy use and carbon emissions**, supported by evidence of actions taken;
- a record of **equipment maintenance and replacement**;
- a **procedure for monitoring and review of performance** against the target, together with a timetable for updating the Carbon Efficiency Plan and capturing lessons learned; and
- the **identity of who "owns" the Plan** at each stage of the project (inception, design, construction, use) and who is responsible for implementing each of the actions.

The CEP may be a stand-alone document or it may be contained within other documents such as:

- the energy chapter of a Sustainability Statement prepared for planning application;
- an organisation's operational Environmental Management Plan;
- a Post Occupancy Evaluation survey;
- a Landlord Energy Statement; or
- a Tenant Energy Review.

The CEP can also form part of a Carbon Trust Carbon Action Plan, which encompasses actions to reduce the overall carbon footprint of an organisation, gaining wider recognition for the carbon reduction achievements.

The CEP should be developed as early as possible in the project / FM service delivery, and evolve as the project/service progresses and various parties take on responsibilities. The client should ensure that contract documents make clear who takes responsibility for developing the CEP at each stage of the project, and for reporting and achieving outcomes. Robust change control processes are needed to ensure the design team are aware of any deviation from the initial performance estimate and specifications, so that the carbon implications of these deviations are understood.

The CEP defines and quantifies the actions to be taken and the roles and responsibilities for achieving operational and embodied carbon reductions. It should include a robust forecast of baseline and targeted performance and be used to track progress. It is important to focus on what is really important to measure. A relatively small amount of good quality data to inform key targets is better than a larger amount of less useful data.

It is important that the CEP is appropriate to the size and complexity of the project. For example, a zonal approach may be needed for large complex projects. More sophisticated tools, such as Dynamic Simulation Models (DSM), may be appropriate in developing energy estimates for such projects.

For a new build project, depending on the procurement route, responsibility may sit with the lead designer initially, who then passes the CEP onto the main contractor as part of the Employer's Requirements. The main contractor will develop the CEP further through detailed design and construction, passing it over to the building owner and/or facilities manager on practical completion of the works to review and maintain the CEP content over the life of the building. A post-completion check should be carried out to ensure the client's requirements have been achieved.

The CEP should include actions and responsibilities for promoting behavioural change within buildings. The way in which people use buildings is important in achieving the designed building performance. The facilities manager should receive appropriate training to enable them to fulfil the requirements of the CEP, and to educate building users. The facilities manager should receive active support from occupier organisation including, for example, a top-level sponsor and building 'champions' to encourage behavioural change.

For existing buildings, if a CEP already exists it should be updated when handed over to a new facilities manager. If a CEP does not exist, one should be developed (by completing the relevant actions) and then responsibility should sit with the facilities manager to review and maintain its content over the life of the building.

Figure 3 (below) summarises the key stages and actions for developing a new CEP.

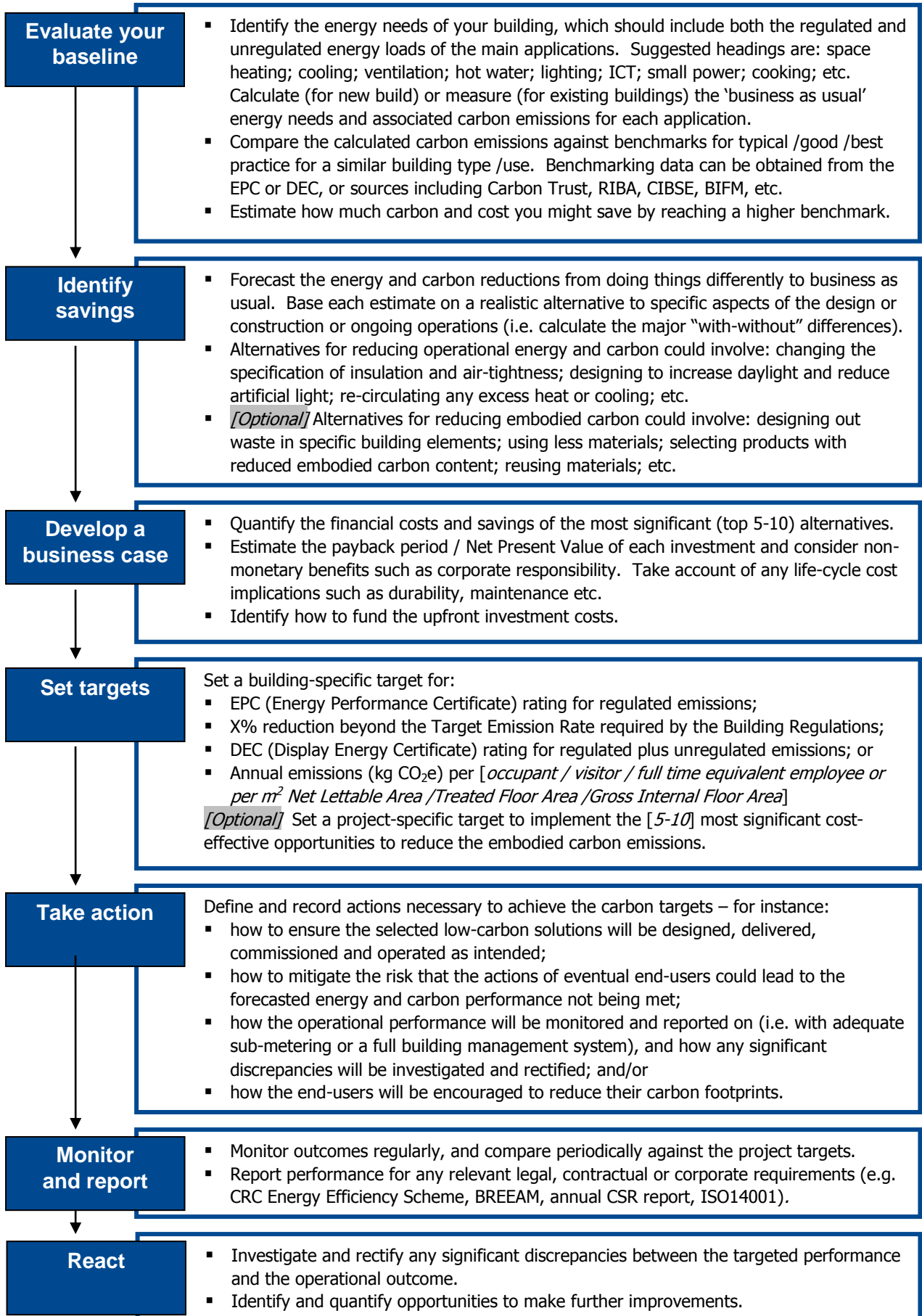


Figure 3: How to develop a Carbon Efficiency Plan

1.4 Estimating embodied carbon

Appendix 2 describes the challenges in measuring embodied carbon when methodologies are in their infancy and clear standards are still being developed. The CEN TC350 standard for the calculation of carbon is under development, and will be a key methodology for measuring embodied (and operational) carbon. As an interim approach, you can learn about reducing embodied carbon (e.g. on a sample project) by setting the model requirement defined in this guide:

"identify the [5-10] most significant cost-effective opportunities to reduce the embodied carbon emissions associated with the project (e.g. through leaner design, designing out waste, reusing materials, and selecting materials with lower embodied carbon over the project life-cycle), quantify the savings made through individual design changes, and report actions and outcomes as part of the Carbon Efficiency Plan"

Figure 4 illustrates how the design team can focus on quantifying the savings associated with individual design changes for specific building elements/components – rather than calculating a carbon footprint for the whole building (and recalculating iteratively as the design is developed).

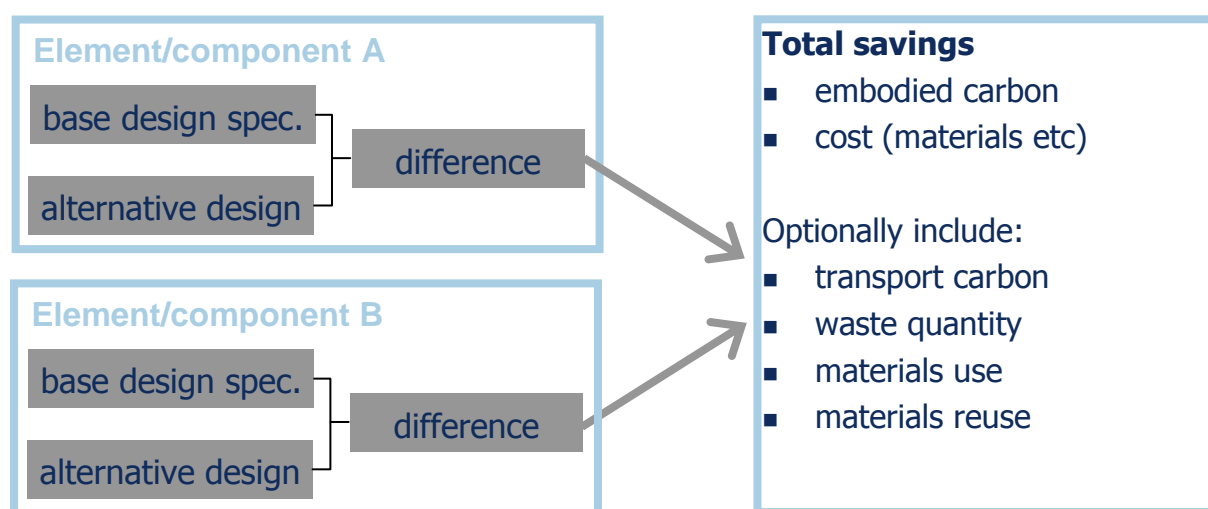


Figure 4: Estimating savings in embodied carbon from alternative design choices for individual building elements/components

The embodied carbon in new build includes both the civil construction element and internal fabric fit-out. It is important to consider both aspects. Specific design changes which may result in significant savings in embodied carbon include:

- changes in the building form to reduce the demand for materials;
- alternative specifications for a building element (e.g. a roof) which use less material;
- selection of alternative materials, such as timber, reused steel or construction products with higher recycled content;
- design options which generate less waste;
- selection of materials with increased durability and recyclability;
- design for deconstruction;
- design for reuse and recovery of materials;
- sourcing heavy materials with a lower transport carbon impact (e.g. locally recycled aggregate instead of stone from a distant quarry);
- specifying materials to have lower embodied carbon (e.g. the use of cement replacements such as PFA and GGBS); and
- specifying passive and mixed mode buildings (to reduce the embodied and operational energy of M&E components)

The WRAP information sheet for construction clients and designers: "Cutting embodied carbon in construction projects" will help you identify basic cost-effective actions to reduce the carbon impact of the materials used in your construction projects^{Error! Bookmark not defined.}.

The design team would be expected to identify changes which are at least cost neutral (or cost saving when identified in the context of a value engineering process), and ensure approval by the structural engineer where appropriate. It is important to consider carbon efficiency throughout the design stages - different aspects will need to be considered at outline and detailed design stages.

Savings are typically calculated by multiplying a change in materials quantity by a carbon emissions factor, or multiplying a materials quantity by a change in carbon emissions factors. Emission factors can be taken from published or commercially available datasets, such as Inventory of Carbon & Energy (ICE)⁹, and material quantities can be derived from cost plan data or a bill of quantities. Figures should be reported in kg CO₂e if possible, in line with international reporting standards, but where this is not possible, reporting may be in kg CO₂. In the absence of agreed standard methods and datasets, clients should ask for evidence that the calculations provided are robust.

Unpublished comparisons of office projects indicate that embodied carbon per m² of floor area varies by a factor of 2-10, with significant (10%+) savings available from individual design choices.

It is anticipated that CEN TC350 will define a harmonised European method for building level assessment of construction products, so that manufacturers will provide embodied carbon data within Environmental Product Declarations. Using this method, embodied carbon will refer to emissions prior to building completion – excluding the embodied carbon content of repairs, maintenance and improvement, and excluding the predicted emissions associated with building end-of-life. Therefore materials reuse would be counted at the build stage but not on deconstruction.

1.5 Additional considerations

Additional design considerations may also include emissions from travel and transport. For example, ensuring design:

- reduces the need for travel (e.g. by allocating space and facilities for video/virtual conferencing);
- supports the use of sustainable transport (e.g. providing facilities for cyclists and charging points for electric vehicles); and
- reduces commercial transport (e.g. reducing the need for ongoing deliveries to service the building, and providing sufficient waste storage areas to reduce the frequency of collections).

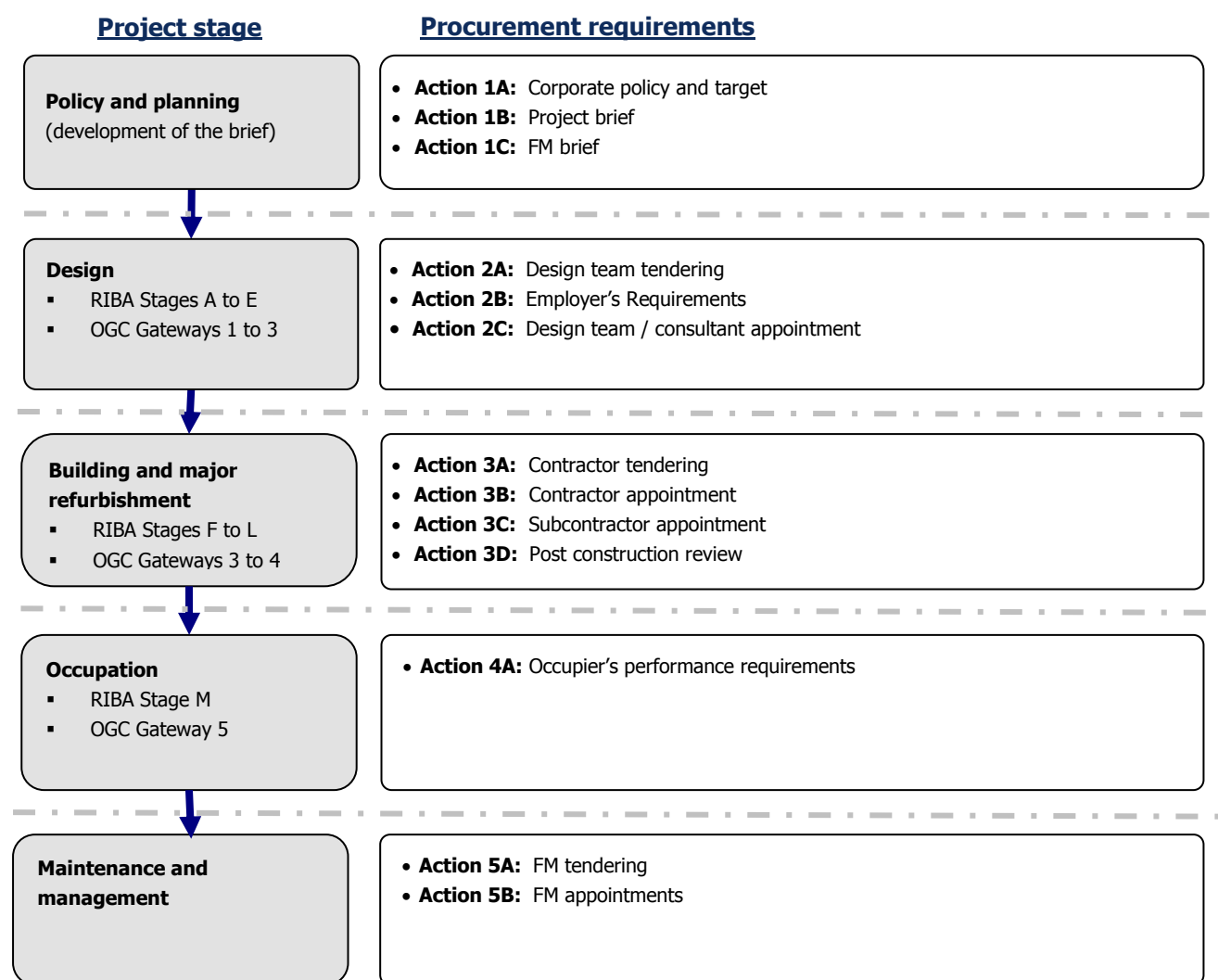
⁹ www.bath.ac.uk/mech-eng/sert/embodied/

2.0 Carbon efficiency through procurement

The approach presented here will help you to clearly define your requirements for carbon efficiency together with how you expect your supply chain to respond for a new build, major refurbishment or building in use¹⁰.

Figure 5 provides a summary of the key steps involved. You can begin by setting a corporate policy and targets for improvement over time, or simply define requirements for a one-off project. In either case, you should specify outcomes for carbon efficiency when appointing designers, contractors and facilities managers.

2.1 Overview of the approach



Acronyms:

- RIBA: Royal Institute of British Architects
- OGC: Office of Government Commerce
- FM: Facilities management

Figure 5: Common project stages and opportunities for incorporating carbon efficiency

¹⁰ Contracting authorities should consider Defra guidance on the 'shadow price of carbon' at the early stages of the procurement process. This guidance is for use in all policy and project appraisals across Government with significant effects on carbon emissions.

2.2 Setting requirements at each stage of the process

To ensure carbon efficiency is embedded throughout the life of the building, it is important to set requirements at each stage of the project process, from in-use through to refurbishment. The diagram below shows where requirements may need to be set by the parties to an owner-occupied building:

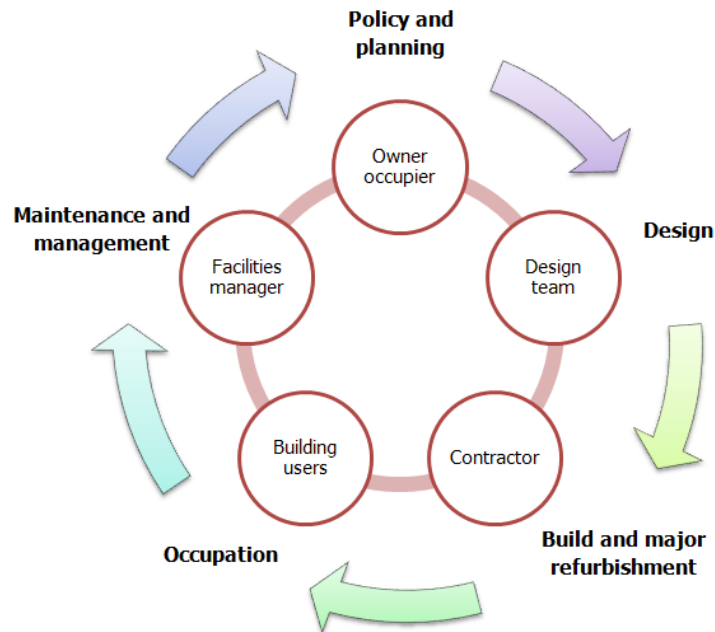


Figure 6: Where requirements may need to be set in owner-occupier buildings

In many buildings, the situation is further complicated by the separation of 'core' and 'tenanted' areas. The design, fit-out and management of tenanted areas is often delivered by a separate supply chain with relatively limited interaction with the teams involved in the design, construction and management of the building as a whole. The diagram below illustrates the process for a tenanted building. The two rings represent the development of the shell & core project and the later fit-out project.

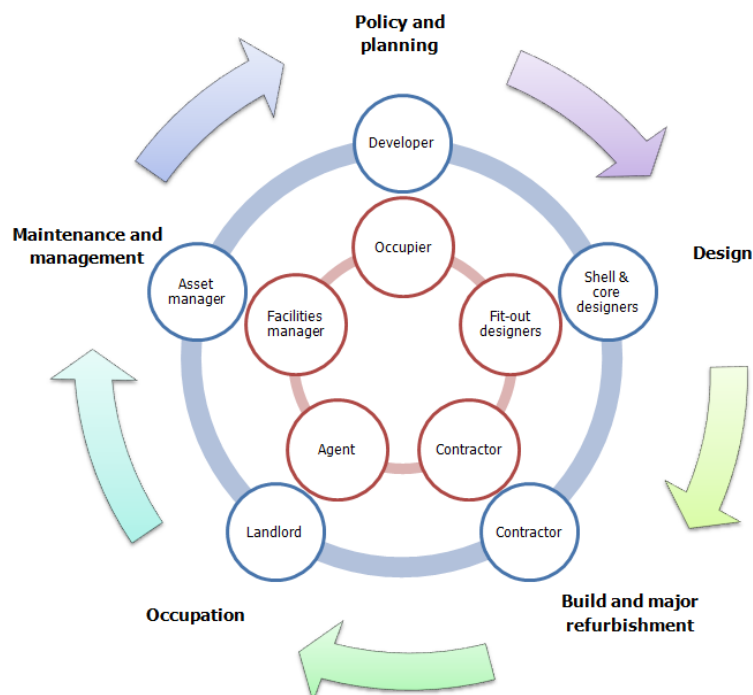


Figure 7: Where requirements may need to be set in tenanted buildings

2.3 Keys to success

In order to make your project a success and improve carbon efficiency, remember the following keys to success:

- **Set a clear policy** and instruct your team or technical advisers to implement it.
- **Allocate responsibility for overseeing carbon efficiency**, including who will be responsible for ensuring appropriate targets are set, and that these flow through to the supply chain, and for monitoring progress to ensure targets are met. This person may also be responsible for managing incorporation of carbon efficiency into procurement requirements. It is likely that responsibility will change over the lifetime of the project, for example:
 - Plan originator Client/Designer/Facilities manager
 - Plan refiner pre-construction Designer
 - Plan refiner during construction Building Contractor
 - Plan maintainer following practical completion Client/Facilities manager
- **Require your design team or FM contractor to develop, review and update a Carbon Efficiency Plan (CEP)** for the project/building ensuring that the carbon efficiency requirements are proportionate to the size and scale of the project/building and based on sound cost benefit analysis and appropriate modelling to ensure the targeted efficiencies are achievable.
- **Review actions defined in the CEP with the design and/or facilities management team** (and other stakeholders where relevant), particularly at each design stage review or procurement gateway.
- **In your ITT and appointment documents, require the design team to consider passive design** and not just technological solutions.
- **Encourage early contractor involvement** in the design process and CEP preparation.
- **Where possible, actively involve lenders, agents, users and occupiers** in discussions with the design and building team.
- **Ensure adequate systems for monitoring carbon performance are in place**, for instance using sub-meters or an automated building management system.
- **Ensure adequate systems for reporting carbon performance are in place**, for instance including the requirement to report on carbon performance to the Client on a monthly basis in the designer's appointment/building contract/facilities management performance specification.
- **Ensure responsible members of staff are made aware of the requirements** and know how to work to meet them.
- If necessary, **consider implementing procurement sanctions to ensure the desired level of performance**, such as a KPI-based approach which triggers remedies and/or penalties for poor performance. Any proposed sanctions should be agreed at the procurement stage, and should reflect the ability of each party (designer, contractor, facilities manager) to control or influence actual outcomes.
- **Manage handover interfaces** between different phases of the project. Ensure roles and responsibilities are clear and all relevant information (along with the Carbon Efficiency Plan) is transferred from one phase to the next.
- **Set a budget** for handover and aftercare work.
- Put in place a programme to **raise awareness and incentivise carbon-efficient behaviour by occupants**.
- **Create a collaborative relationship** between the developer, owner and occupier(s). This will involve:
 - communicating carbon efficiency goals and targets throughout the supply chain;
 - avoiding activities / alterations (e.g. during fitout) that compromise the energy performance of the building;
 - gathering and sharing data on performance and opportunities for improvement; and
 - agreeing a reasonable approach to implementing carbon-saving measures that demonstrate a sound business case and for allocating the associated costs and benefits.

3.0 Policy and planning

3.1 Corporate policy, objectives and performance measurement

Many organisations set broad corporate policies or targets relating to carbon. The challenge is to make these targets quantifiable, and able to be benchmarked against industry standards. It is important to get your policy, targets and performance measures right, as these will flow through into supply chain requirements.

Different clients, facilities managers or principal contractors will be able to commit to differing levels of carbon efficiency practice. This procurement guide provides a framework that allows for differing levels of practice, so that you can choose to take a leading edge or good practice approach, depending on your capabilities and business strategy.

Communicating your policy and objectives to your supply chain is vital to clarify expectations. In addition, some clients may wish to set procurement sanctions to help manage performance. Common mechanisms include KPI-based award/penalty schemes ('pain/gain'), whereby contractors receive reduced payments if they fail to meet targets but receive a share of the benefit if they exceed targets (at a rate set out in the contract), for example in relation to energy use. This type of scheme may also be useful in encouraging landlords to implement low carbon refurbishment and retrofit options. Refer to OGC Energy Efficiency in Facilities Management Contracts: Guidance and Suggested Clauses for model wording for pain/gain mechanisms¹¹.

Similar mechanisms can also be used to withhold final payments until agreed actions are completed; for example, post-construction testing demonstrates the building operates in accordance with the design specification and/or the provision of appropriate training and guidance on the use of building space and systems.

Another common mechanism on multi-supplier frameworks is the use of a 'league table' where results are published on a KPI dashboard. Often the incentive of seeing peer group performance is enough to incentivise improvement. However, such a system should be fair and reasonable (i.e. taking account of those factors which a designer, contractor or facilities manager can and cannot control), and any penalties should be agreed at the procurement stage.

A new build designer or contractor cannot fully determine the performance of the whole building while in use, since this is significantly dependent on occupant behaviour. Likewise, the facilities management provider has limited influence over occupant behaviour. However, the designer, contractor and facilities management provider can influence three important aspects, which therefore should be the focus of procurement requirements:

- energy use and embodied carbon specifications of components installed during new build or retrofit/refurbishment;
- design and commissioning of an efficient system (including features designed to influence behaviour, such as auto switch-off); and
- building management and maintenance, including making occupants aware of the savings they can contribute.

Clients can set requirements for a number of mechanisms to help ensure in-use carbon emissions meet design expectations and corporate targets. These include:

- frameworks such as Soft Landings¹², within which designers and constructors get involved with building occupants before and beyond practical completion to smooth the transition, fine-tune and de-bug the systems, and ensure occupiers understand how to control and best use the building. Requirements for carbon efficiency fit well within this wide-ranging framework;
- the production of a Building Users' Guide during design and construction; and

¹¹ . OGC (2011) *Energy Efficiency in Facilities Management Contracts: Guidance and Suggested Clauses*

¹² www.bsria.co.uk/services/design/soft-landings/

- Post Occupancy Evaluation of similar buildings in use, which can be used to benchmark performance, identify the important factors and how to continually improve.

3.1.1 Action 1A: Corporate policy and objectives

The following wording can be used by clients, tenants and facilities managers in setting corporate policy and objectives.

Within your Corporate Social Responsibility (CSR), Sustainability or Energy policy document:

“As part of our commitment to having a low environmental impact in [our business/ buildings/ operations], we aim to reduce our operational [and embodied] carbon emissions. We will:

- set a target for improving the carbon efficiency and reducing energy consumption of our new and existing buildings;
- embed the target within corporate policy and processes;
- set corresponding requirements in project procurement and engage with our supply chain;
- measure performance at a building level; and
- report annually on overall carbon emissions and savings made.”

Objectives

To increase the carbon efficiency of [our new buildings; buildings we occupy; buildings we manage and maintain] we will:

[delete as appropriate]

- require a Carbon Efficiency Plan for each building/project (or equivalent);
- for construction or refurbishment projects:
 - define and achieve project-specific targets for [as-designed / in-use] operational carbon efficiency [and savings in embodied carbon], taking into account corporate and regulatory requirements, potential outcomes and cost-effectiveness;
 - achieve the credits for operational carbon emissions [and embodied carbon] required to attain a [BREEAM/LEED/Code for Sustainable Homes/other] rating of [XXX];
- for existing buildings:
 - define and achieve building-specific targets for operational energy and associated carbon emissions, taking into account corporate and regulatory requirements, potential outcomes and cost-effectiveness;
- for the corporate portfolio:
 - achieve annual emissions of no more than [x]kg CO₂e per occupant / visitor / full time equivalent employee or per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area; or
 - reduce predicted/in-use carbon emissions by X% by 20xx compared to baseline performance in 20yy.

3.2 KPIs, targets, roles and responsibilities

As client, the responsibility for setting policy and initiating the process of planning for carbon efficiency sits with you. You should clearly indicate to the supply chain your targets, and the roles and responsibilities for achieving them. Targets set at design should be periodically reviewed and revised as more detail becomes available (e.g efficiencies and load profiles of specified systems, and end-user's intended hours of operation).

There are merits and disadvantages to different types of target for operational carbon emissions:

Target based on	Advantages	Disadvantages
Energy Performance Certificate (EPC)	Agreed method for calculation Measures predicted outcome, which relates more closely to what the designer and contractor can control	Focuses on regulated emissions – omits a significant fraction of emissions Does not measure actual outcome for building in use
Display Energy Certificate (DEC)	Relates to actual outcome for building in use	Difficult to forecast – especially where the client will not be the occupier Problematic asking design teams and contractors to deliver an outcome which they cannot fully control
CO ₂ e emissions / energy use per unit area or per occupant	May be defined in terms of predicted design outcome or actual outcome for building in use	Difficult to forecast actual outcome Problematic asking design teams and contractors to deliver an outcome which they cannot fully control Reliable benchmarks are not readily available, and building occupancy may be unpredictable
Reduction in emissions below Building Regulations	Agreed method for calculation Measures predicted outcome, which relates more closely to what the designer and contractor can control Enables client to learn how to meet the lower emissions targets of future Building Regulations	Focuses on regulated emissions – omits a significant fraction of emissions Does not measure actual outcome for building in use

Some commercial property developers apply a % target for reducing emissions below Building Regulations, since this clearly represents a move towards good practice, is readily measured, and relates to what a design team and contractor can be contractually obliged to deliver.

Roles	Responsibilities
Client's development / sustainability / environmental / energy manager (for new build) OR facilities manager (for existing buildings)	<ul style="list-style-type: none"> Responsible for including KPIs, targets and standard requirements in corporate policy documents (CSR, environment, procurement policies etc)
Top-level management	<ul style="list-style-type: none"> Responsible for corporate sign-off on targets, and allocating resources to deliver
Procurement manager	<ul style="list-style-type: none"> Responsible for including requirements for carbon efficiency in project appointments, starting with the client's technical advisers and design team, and drawing this to the attention of bidders Where appropriate, build standard clauses into template procurement documents applying to all projects

Client's construction/asset manager or technical adviser (where appointed)	<ul style="list-style-type: none"> ■ Help translate the corporate targets into project-specific targets to include in the Project Brief or Facilities Management Brief ■ Check that the project-specific targets are being met at each stage of the project ■ Report to the client regularly on progress, issues and potential variations
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KPIs

- Operational carbon:
 - annual kg CO₂e per occupant / visitor / full time equivalent employee OR per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area;
 - annual kWh per occupant / visitor / full time equivalent employee OR per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area;
 - EPC rating of [X];
 - predicted DEC rating of [Y];
- [*Optionally*] Embodied carbon:
 - reduction in kgCO₂e/m².

Note: For KPIs given in this guide, kg CO₂e should be used if possible; otherwise reporting may be in kg CO₂.

Corporate targets

For new build and major refurbishment:

- achieve a minimum design outcome for predicted operational carbon emissions at building level:
 - an EPC rating of [x] for regulated emissions; and/or
 - a reduction of [x]% beyond the Target Emission Rate required by Building Regulations 2010; and/or
 - a predicted DEC of [y] for regulated and unregulated emissions; and/or
 - annual emissions of no more than [x] kg CO₂e per occupant / visitor / full time equivalent employee or per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area.
- [*where applicable*] achieve the credits for operational carbon emissions [and embodied carbon] required to meet a BREEAM / LEED / Code for Sustainable Homes rating of XXX (or equivalent).
- [*optionally*] each project implements at least [five] of the most significant cost-effective opportunities to reduce its embodied carbon emissions.

For buildings in use:

- meet or exceed an operational target for each building of:
 - annual carbon emissions of not more than [x] kg CO₂e per occupant / visitor / full time equivalent employee OR per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area; and/or
 - annual energy consumption of not more than [x] kWh per occupant / visitor / full time equivalent employee OR per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area; and/or
 - a DEC rating of [Y]; and/or
- for the corporate portfolio, achieve an [x]% reduction in energy/carbon emissions by 20xx relative to performance in 20[yy].

The UN Environment Programme's Sustainable Buildings and Climate Initiative has adopted a standard method for measuring operational carbon, known as the Common Carbon Metric¹³. To calculate the metric, the energy intensity of the building and the associated equivalent carbon dioxide intensity are required, i.e.

Energy Intensity = kWh/m²/year (kilowatt hours per square metre per year)

Carbon Intensity = kgCO₂e/m²/year (kilograms of carbon dioxide equivalent per square metre per year); or, kgCO₂e/occupant/year (kilograms of carbon dioxide equivalent per occupant per year)

The scope is the emissions associated with building energy end-use: purchased electricity, purchased cooling/steam/heat, and/or on-site generated power used to support the building operations. If available, emissions associated with fugitives and refrigerants used in building operations should be reported separately. Greenhouse gas (GHG) emissions are calculated by multiplying the Energy Intensity by the official GHG emission coefficients used under national reporting, for the year of reporting, for each fuel source used.

The Green Property Alliance has published advice¹⁴ on sustainability metrics for commercial property. They recommend using m² of Net Lettable Floor Area as the default denominator when normalising indicators, as occupancy-based indicators can be problematic and therefore less reliable as a basis for benchmarking.

There is currently no similar internationally agreed metric for embodied carbon. However the work of CEN TC350¹⁵ will provide a harmonised standard to ensure consistency across Europe. Within this, prEN 15804¹⁶ provides a methodology for calculating the kgCO₂e, which can then be indexed as appropriate. See Appendix 2 for further details.

3.3 Procurement clauses

The wording below provides:

- a model **Project Brief** for the procurement of designers and contractors for a new build project or major refurbishment project, particularly where replacement of energy plant and equipment is within the scope of work; and
- a model **Facilities Management Brief** for the procurement of FM services for existing assets – including maintenance and retrofit works.

Where the client employs a technical adviser, they will be responsible for:

- helping define the project-specific / building-specific targets;
- advising on the content of the project/FM brief;
- checking that the targets are being met; and
- reporting back to the client.

Where the client does not employ a technical adviser, the client should identify someone internally who will have this responsibility.

¹³ www.unep.org/sbcj/pdfs/UNEP_SBCI_CarbonMetric.pdf

¹⁴ http://www.bpf.org.uk/en/files/bpf_documents/Common_Metrics_Paper_FINAL.pdf

¹⁵ *The European standard for assessing the environmental impacts of the built environment:* https://www.cen.eu/cen/Sectors/Sectors/Construction/SustainableConstruction/Pages/CEN_TC350.aspx

¹⁶ *The proposed (denoted by 'pr') EN15804 standard sets out a methodology for calculating kg CO₂e.* <https://www.cen.eu>

3.3.1 Action 1B: Project Brief

"As part of our commitment to reducing resource use in all of our developments and cutting the associated costs, we require all new build and refurbishment projects to pursue carbon efficiency. This involves reducing as-designed and as-built operational carbon impacts [and the embodied carbon associated with the selected construction materials].

Targets

We endorse the principle of going beyond the minimum requirements of applicable laws, for example the Building Regulations, where cost effective. This project must:

- achieve our minimum design requirements for [regulated and unregulated] operational carbon emissions of [delete as appropriate]:
 - an EPC (Energy Performance Certificate) rating of [X] for regulated emissions;
 - a reduction of [X]% beyond the Target Emission Rate required by Building Regulations 2010;
 - a predicted DEC (Display Energy Certificate) rating of [Y] for regulated and unregulated emissions; or
 - annual carbon emissions of not more than [x] kg CO₂e per [occupant / visitor / full time equivalent employee OR per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area];
- achieve the credits for operational carbon emissions [and embodied carbon] required to meet [a BREEAM / LEED / Code for Sustainable Homes rating of XXX (or equivalent)];
- develop and implement a Carbon Efficiency Plan (or equivalent) from early design stage, to include the elements detailed below; and
- [optional] reduce carbon emissions associated with the construction process.

Embodied carbon [optional]

For embodied carbon, identify the [5-10] most significant and cost-effective opportunities to reduce the embodied carbon emissions associated with the project (e.g. through leaner design, designing out waste, reusing materials, and selecting materials with lower embodied carbon over the project life-cycle), quantify the savings made through individual design changes, and report actions and outcomes as part of the Carbon Efficiency Plan.

Carbon Efficiency Plan

The team is required to develop a Carbon Efficiency Plan (CEP) for the project (or equivalent), commencing at the concept design stage or before. The CEP should include:

- a forecast for operational energy and associated carbon emissions (including regulated and unregulated emissions), taking account of:
 - building-level emissions considered within the Building Regulations asset rating (quantified using SAP (Standard Assessment Procedure)/SBEM (Simulated Building Energy Model)/DSM (Dynamic Simulation Model) tools, as appropriate to the scale and complexity of the project);
 - key features that demonstrate compliance or improvement on the asset rating;
 - building-level emissions for significant energy uses not considered within the asset rating, such as:
 - [delete as appropriate]
 - external and/or sports pitch lighting;
 - regional IT server racks;
 - communal facilities;
 - catering facilities;
 - multimedia;
 - etc.
 - adjustments to particular values within the national calculation methodology used to establish the asset rating and forecast, taking account of:

- ramp-up of building occupancy levels;
- daily and seasonal profiles of usage;
- impact of energy management practices in operation;
- performance of low carbon and renewable energy technologies;
- etc.

- a cost-effective, project-specific target which meets or exceeds regulatory requirements;
- the key design parameters by which the target will be achieved, including accepted performance tolerances and verification procedures;
- actions to be taken in design, equipment specification, construction, commissioning and post-completion to reduce carbon emissions and ensure effective implementation (with clearly identified responsibilities of relevant parties), including actions to:
 - reduce the building's energy requirements;
 - source low carbon energy;
 - ensure effective commissioning during pre-handover, occupation and aftercare;
 - raise awareness and educate building users about carbon efficiency through, for instance, a building users' guide and occupant induction sessions; and
 - enable the effective monitoring of actions to reduce operational carbon (e.g. additional sub-metering or a building management system).

Potential actions should be identified, highlighting and prioritising those providing the most significant benefit.

[Optional for embodied carbon:

- the most significant and cost-effective actions to reduce embodied carbon, including:
 - selecting alternative materials;
 - reducing the quantity of materials required;
 - designing out waste and reducing wastage rates;
 - selecting materials with longer life expectancy;
 - alternatively sourcing and/or transporting products to site;
 - increasing recovery and reuse of materials (reclaimed and higher recycled content);
- information on the data and evaluation method used for embodied carbon, to inform future assessment by our organisation].

Reporting

The project team will include the Carbon Efficiency Plan (CEP) [together with supporting carbon/energy calculations and energy/carbon models] within both Scheme and Detailed design reports [*or comparable documents as appropriate*] for client RIBA Stage and/or project Gateway reviews, with the final CEP presented within the Contractor's Proposals.

The project team will ensure requirements are applied and clearly communicated to relevant contractors and subcontractors. In particular, define key features demonstrating compliance or improvement on applicable laws (including the Building Regulations) [including any defined levels of performance for construction components, central plant and equipment, or specifications to be used for subsequent fit-out of tenanted areas].

The project team will submit evidence that the minimum requirements and any other measures specified in the CEP have been implemented. This may take the form of certified post-construction environmental and carbon ratings for the building or evidence that components meeting the intended standards have been installed and appropriately commissioned."

3.3.2 Action 1C: Facilities Management Brief

"As part of our commitment to reducing resource use in all of our developments and cutting the associated costs, we require the facilities management of our buildings to pursue carbon efficiency with respect to the operational carbon emissions and the associated consumption of heat and power.

Targets

We endorse the principle of going beyond the minimum requirements of applicable laws, where cost effective. This building must:

- meet or exceed the operational target for the building of [*delete as appropriate*]
 - annual carbon emissions of not more than [x] kg CO₂e per [occupant / visitor / full time equivalent employee OR per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area]; and/or
 - annual energy consumption of not more than [x] kWh per [occupant / visitor / full time equivalent employee OR per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area]; and/or
 - a DEC (Display Energy Certificate) rating of [Y]; and/or
 - [x]% reduction in energy/carbon emissions relative to performance in 20[xx].

To assist us in meeting these targets, we expect our asset manager and facilities manager to develop and/or implement a Carbon Efficiency Plan (or equivalent), to include the elements detailed below.

The asset manager will be required to take steps to meet or exceed the operational target for the building. The facilities manager will be required to:

- measure and report performance on a periodic (e.g. quarterly) basis or as required to meet legal (e.g. CRC Energy Efficiency Scheme) and other reporting requirements. Reports should be supported by evidence in the form of utility bills and should present:
 - the energy consumption in kWh split by fuel source for the areas for which facilities management have responsibility;
 - the carbon emissions associated with this energy consumption based on the carbon conversion factors published by DECC (Department of Energy and Climate Change) for use in CRC reporting;
 - the floor area / occupants / visitors / full time equivalent employees for the areas to which the facilities management contract applies; and
 - overall energy and carbon efficiency in the form of annual kWh and kg CO₂e per occupant / visitor / full time equivalent employee or per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area.
- provide the business case for any actions to reduce carbon emissions – based on the estimated capital and lifecycle costs of the recommended works, the value of reduced carbon emissions and the allocation of costs and benefits between parties.

Carbon Efficiency Plan

The asset manager / facilities manager is required to implement or (where none currently exists) develop a Carbon Efficiency Plan (CEP) for the project, commencing at handover and occupation. The CEP should include:

- a forecast for operational energy and associated carbon emissions;
- targets for reducing operational energy and associated carbon emissions – which should be SMART (i.e. Specific, Measurable, Achievable, Relevant and Time-based);
- management actions and investment priorities for reducing cost and improving carbon efficiency, e.g.:

[*delete as necessary subject to the scope of the FM contract*]

- additional metering to enable effective reporting and management;
- regular energy profile audits to establish normal and abnormal operating behaviour, and identify energy inefficiencies and priorities for remedial work;
- switching to low and zero carbon technologies and fuel sources;

- encouraging responsible energy use by occupants; and
- *[include if appropriate]* agreeing capital investment with other parties (e.g. tenant, landlord or asset manager).

- a timetable for reviewing and updating the CEP to reflect trends in actual performance and availability of better technologies.

The asset manager/facilities manager will review and update the plan in accordance with the specified timetable, to ensure the availability of up-to-date information.

Implementation

The facilities manager is required to implement cost-effective initiatives in line with the agreed CEP:

[delete as necessary subject to the scope of the FM contract]

- maintain the facilities (building, plant and equipment, including controls and monitoring systems) so that they work safely and in line with their design performance;
- monitor energy consumption and associated carbon emissions in line with the metrics described above;
- reduce carbon emissions and energy consumption through management and maintenance of facility operations and building, plant and equipment;
- reduce carbon emissions and energy consumption through targeted replacement or retrofitting of building, plant and equipment;
- reduce carbon emissions and energy consumption by taking actions to change the behaviour of occupants;
- *[include if appropriate]* ensure energy-using technologies are maintained and serviced by appropriately qualified professionals in line with the manufacturer's instructions; and
- ensure their subcontractors implement actions as defined in the CEP.

Reporting

The facilities manager is required to report performance of the building and plant on a *[monthly/quarterly/annual]* basis against the targets stated above and provide appropriate evidence.

The facilities manager should inform the asset manager and the occupier as to any issues they believe have arisen with the building's carbon efficiency, and make recommendations to the asset manager on any major works or replacement to improve carbon efficiency.

The asset manager will liaise with the facilities manager to assess the business case for action (replacement, refurbishment etc) to improve carbon efficiency. The asset manager will ensure the owner and/or occupier receives accurate and useful information on current performance and plans for improvements.

Reacting

The facilities manager is required to:

- check for, and respond promptly to, identified underperformance or malfunctions;
- *[include if appropriate]* provide evidence and support on negotiations for capital investment with other parties (e.g. tenant, landlord or asset manager); and
- update the CEP to take account of the actual performance of facilities, changes in occupier requirements and the market drivers for carbon savings, and the availability of new systems or low carbon or renewable technologies."

4.0 Design

4.1 Introduction

Construction clients should use the model wording in this Section when procuring a design team. Good practice requires consideration of operational (and potentially embodied) carbon efficiency from an early design stage when it can most effectively be incorporated into the design.

The procurement wording must be applied to those charged with design¹⁷ responsibility for your project, and to the Technical Adviser if one is appointed. Irrespective of procurement route adopted (traditional, design & build, PFI etc), the model wording can be inserted in design team Pre-Qualification Questionnaires (PQs), Invitation to Tender (ITT) documents, and consultant appointment contracts.

4.2 Key opportunities and decisions

The operational carbon can be estimated by considering the regulated and unregulated emissions. Obtaining a headline value for regulated emissions will involve calculating the desired EPC rating and Building Regulations maximum permissible kg CO₂e/m²/yr. Obtaining a headline value for unregulated carbon emissions may involve considering the likely DEC rating or intended kg CO₂e/year indexed against building usage.

Passive design solutions which bring long-term carbon efficiencies when the building is in use should be selected first, followed by technological solutions which require installation of (often costly) kit. Carbon efficiency must be considered as part of a holistic design strategy including cost, usability and sustainability.

For embodied carbon, materials selection is vital and should be considered in early options appraisal. Generic data can be used for an initial assessment of the savings potential in key building elements.

4.3 KPIs, targets, roles and responsibilities

Roles	Responsibilities
Procurement manager	<ul style="list-style-type: none">■ To procure a design team with suitable skills and experience in cost-effectively improving carbon efficiency■ To set project-specific requirements on the design team to reduce operational carbon and (optionally) embodied carbon
Technical advisor or internal specialist	<ul style="list-style-type: none">■ To define the project-specific targets■ To check the project targets are being met■ To report regularly to the client on progress against the targets and, where necessary, suggest alterations or improvements
Design team	<ul style="list-style-type: none">■ To forecast and design for carbon efficiency, looking for the top opportunities to make savings■ To develop a Carbon Efficiency Plan and include this within design reports
Client	<ul style="list-style-type: none">■ To brief the design team on the carbon targets upon appointment■ To review the Carbon Efficiency Plan at design stage reviews and procurement gateways

¹⁷ Design should be defined broadly and includes all consultant services that impact on the nature, extent, quality and cost of the project.

KPIs

- Operational carbon:
 - annual kg CO₂e per occupant / visitor / full time equivalent employee OR per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area;
 - annual kWh per occupant / visitor / full time equivalent employee OR per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area;
 - EPC rating of [X];
 - predicted DEC rating of [Y];
- [*Optionally*] Embodied carbon:
 - reduction in kg CO₂e/m²

Targets

- Achieve a minimum design outcome for predicted operational carbon emissions at building level:
 - an EPC rating of [x] for regulated emissions; and/or
 - a reduction of [x]% beyond the Target Emission Rate required by Building Regulations 2010; and/or
 - a predicted DEC of [y] for regulated and unregulated emissions; and/or
 - annual emissions of no more than [x] kg CO₂e per occupant / visitor / full time equivalent employee or per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area.
- [*Where applicable*] Achieve the credits for operational carbon emissions [and embodied carbon] required to meet a BREEAM / LEED / Code for Sustainable Homes rating of XXX (or equivalent).
- [*Optionally*] Each project implements at least [five] of the most significant cost-effective opportunities to reduce its embodied carbon emissions.

4.4 Procurement clauses

4.4.1 Action 2A: Design team tendering

Pre-Qualification Questionnaire (PQQ) and Invitation to Tender (ITT)

PQQ wording

These probe the general capability of a design team to forecast and design for cost-effective carbon reductions. The third question (on embodied carbon) may be appropriate for more complex projects or where a high standard of performance is sought.

"As part of our commitment to reducing resource use in all of our developments and cutting the associated costs, we require all new build and refurbishment projects to pursue carbon efficiency. This involves reducing as-designed and as-built operational carbon impacts [and the embodied carbon associated with the selected construction materials].

Specific targets for this project are to [*insert relevant targets from Project Brief*]. Further detail is provided in the Project Brief.

1. Detail your understanding and experience in achieving design solutions that cost-effectively reduce operational carbon emissions and the consumption of heat and power in buildings¹⁸.
2. Detail your understanding and experience in developing Carbon Efficiency Plans (or equivalent) that provide a robust forecast of carbon emissions together with defined and costed proposals for achieving improved standards of carbon efficiency without compromising value for money.
3. [*Optionally*] Detail your understanding and experience in cost-effectively designing out embodied carbon."

¹⁸ The Regulations contain an exhaustive list of references or evidence that potential services provider can be required to provide to prove their technical or professional ability (Regulation 25 of the Public Contracts Regulations 2006). The evidence requested must only relate to the specific contract itself – not to the operation of the services provider's whole business

An ideal PQQ response would provide the following details:

- evidence of how the bidder has previously identified opportunities to reduce operational carbon emissions and the consumption of heat and power, with an understanding of the associated financial and performance factors;
- evidence of having developed Carbon Efficiency Plans (or similar) to inform clients of the options available to them to reduce carbon emissions with life-cycle financial savings; and
- [*optionally*] evidence of understanding of embodied carbon emissions, the various design and specification options that can be pursued to reduce embodied carbon and their cost-effectiveness – including designing for less material, reducing wastage of materials, and using materials of reduced embodied carbon content.

ITT wording

These clauses ask designers to explain how they will forecast the operational (and embodied) carbon emissions, identify and prioritise actions to reduce these and assess the net costs and benefits of more carbon-efficient solutions as part of the design development process.

“As part of our commitment to reducing resource use in all of our developments and cutting the associated costs, we require all new build and refurbishment projects to pursue carbon efficiency. This involves reducing as-designed and as-built operational carbon impacts [and the embodied carbon associated with the selected construction materials].

Specific targets for this project are to [*insert relevant targets from Project Brief*]. Further detail is provided in the Project Brief.

Please describe your approach to:

1. achieving our minimum requirements; and
2. preparing a Carbon Efficiency Plan (or equivalent) in line with the requirements set out in the Project Brief.

Please identify any factors you believe to be significant to the cost-effective achievement of operational [and embodied] carbon efficiency targets set for this project.”

An ideal ITT response would provide the following details:

- an outline of their proposed approach to planning for operational [and optionally, embodied] carbon efficiency, which should include all of the areas listed in the Project Brief;
- how the bidder will evaluate capital, lifecycle and operating costs in the context of (a) the tenant/occupier motivations to be more carbon efficient and (b) the allocation of capital costs and savings between client/developer and tenant/occupier;
- a clear method for developing the most cost-effective combination of efficiency measures to meet the project minimum requirements, and for quantifying and evaluating opportunities to go beyond the minimum requirements where these provide value for money to the client; and
- consideration of the links between carbon reduction and other specific project requirements, such as a BREEAM / LEED / Code for Sustainable Homes requirement, or carbon or renewable energy planning statements.

4.4.2 Action 2B: Employer’s Requirements

Employer’s Requirements at design stage, for Design & Build or PFI contracts

The client can issue these Employer’s Requirements when tendering for their own design team (alongside the ITT wording above), or when tendering for a D&B/PFI contractor who, depending on procurement route, may appoint their own design team.

These clauses ensure D&B/PFI contractors and their design teams will systematically consider carbon reduction as part of the design development process.

"As part of our commitment to reducing resource use in all of our developments and cutting the associated costs, we require all new build and refurbishment projects to pursue carbon efficiency. This involves reducing as-designed and as-built operational carbon impacts [and the embodied carbon associated with the selected construction materials].

We require all installed energy consuming and generating plant and equipment to achieve, as a minimum, the performance requirements defined by [e.g. the Domestic Building Services Compliance Guide / the Non-Domestic Building Services Compliance Guide / (when designing an internal fit-out) the previous on-construction Part L submission / the Table below].

Targets

The design team must:

- achieve our minimum design requirements for [regulated and unregulated] operational carbon emissions of [insert relevant targets from Project Brief and delete others as appropriate]:
 - an EPC (Energy Performance Certificate) rating of [X] for regulated emissions; and/or
 - a reduction of [X]% beyond the Target Emission Rate required by Building Regulations 2010; and/or
 - a predicted DEC (Display Energy Certificate) rating of [Y] for regulated and unregulated emissions; and/or
 - annual carbon emissions of not more than [x] kg CO₂e per [occupant / visitor / full time equivalent employee OR per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area];
- achieve the credits for operational carbon emissions [and embodied carbon] required to meet [a BREEAM / LEED / Code for Sustainable Homes rating of XXX (or equivalent)].

Embodied carbon [optional]

We are committed to reducing the embodied carbon in the construction and disposal of our buildings. The design team must:

- identify the [5-10] most significant and cost-effective opportunities to reduce the embodied carbon emissions associated with the project (e.g. through leaner design, designing out waste, reusing materials, and selecting materials with lower embodied carbon over the project life-cycle);
- quantify the savings made through individual design changes; and
- report actions and outcomes as part of a Carbon Efficiency Plan.

Carbon Efficiency Plan

The design team is required to develop a Carbon Efficiency Plan (CEP) for the project (or equivalent), commencing at the concept design stage or before. The CEP should include:

- a forecast for operational energy and associated carbon emissions (including regulated and unregulated emissions), taking account of:
 - building-level emissions considered within the Building Regulations asset rating (quantified using SAP (Standard Assessment Procedure)/SBEM (Simulated Building Energy Model)/DSM (Dynamic Simulation Model) tools, as appropriate to the scale and complexity of the project);
 - key features that demonstrate compliance or improvement on the asset rating;
 - building-level emissions for significant energy uses not considered within the asset rating, such as:
[delete as appropriate]
 - external and/or sports pitch lighting;
 - regional IT server racks;
 - communal facilities;
 - catering facilities;
 - multimedia;
 - etc.

- adjustments to particular values within the national calculation methodology used to establish the asset rating and forecast, taking account of:
 - ramp-up of building occupancy levels
 - daily and seasonal profiles of usage;
 - impact of energy management practices in operation;
 - performance of low carbon and renewable energy technologies;
 - etc.

■ a cost-effective, project-specific target which meets or exceeds regulatory requirements:

- reducing the building's energy requirements in preference to supplying more low carbon energy;
- predicting the carbon savings from passive design and proposed technical solutions;
- avoiding excessive responsibility on facilities management or building users to achieve the design target under normal operation; and
- providing a basis for monitoring and evaluation of actions to reduce operational carbon;

■ the key design parameters by which the target will be achieved, including accepted performance tolerances and verification procedures;

■ actions to be taken in design, equipment specification, construction, commissioning and post-completion to reduce carbon emissions and ensure effective implementation (with clearly identified responsibilities of relevant parties), including actions to:

- reduce the building's energy requirements;
- source low carbon energy;
- ensure effective commissioning during pre-handover, occupation and aftercare;
- raise awareness and educate building users about carbon efficiency through, for instance, a building users' guide and occupant induction sessions; and
- enable the effective monitoring of actions to reduce operational carbon (e.g. additional sub-metering or a building management system).

Potential actions should be identified, highlighting and prioritising those providing the most significant benefit.

[Optional for embodied carbon:

■ the most significant and cost-effective actions to reduce embodied carbon, including:

- selecting alternative materials;
- reducing the quantity of materials required;
- designing out waste and reducing wastage rates;
- selecting materials with longer life expectancy;
- alternatively sourcing and/or transporting products to site;
- increasing recovery and reuse of materials (reclaimed and higher recycled content); and

■ information on the data and evaluation method used for embodied carbon to inform future assessment by our organisation].

Reporting

The design team will include the Carbon Efficiency Plan (CEP) [together with supporting carbon/energy calculations and energy/carbon models] within both Scheme and Detailed design reports [*or comparable documents as appropriate*] for client RIBA Stage and/or project Gateway reviews and for incorporation in documents used for contractor tendering.

The design team will provide projected financial, carbon and energy savings and associated financial costs from going beyond the minimum requirement for the project [and *if appropriate*, the contribution to meeting the project's target environmental rating for BREEAM or the Code for Sustainable Homes or other targets] ;

The design team will ensure requirements are applied and clearly communicated to relevant contractors and subcontractors. In particular, the design team will define key features demonstrating compliance or improvement on applicable law (including the Building Regulations) [including any defined levels of performance for construction components, central plant and equipment, or specifications to be used for subsequent fit-out of tenanted areas].

The design team will highlight the key parameters/assumptions on which cost/benefit analysis and modelling are based, to ensure the implications of amending these are fully understood.

The design team will submit evidence that the minimum requirements and any other measures specified in the CEP have been implemented. This may take the form of certified post-construction environmental and carbon ratings for the building or evidence that components meeting the intended standards have been installed and appropriately commissioned.”

4.4.3 Action 2C: Design team / consultant appointment

Appointment document (e.g. consultant contract)

These clauses ensure designers will agree actions they will take to increase carbon efficiency as part of the design development process, and will inform the client and principal contractor of design decisions and intended outcomes.

“As part of our commitment to reducing resource use in all of our developments and cutting the associated costs, we require all new build and refurbishment projects to pursue carbon efficiency. This involves reducing as-designed and as-built operational carbon impacts [and the embodied carbon associated with the selected construction materials].

Targets

We endorse the principle of going beyond the minimum requirements of applicable laws (including the Building Regulations), where cost effective. This project must:

- achieve our minimum design requirements for [regulated and unregulated] operational carbon emissions of [delete as appropriate]:
 - an EPC (Energy Performance Certificate) rating of [X] for regulated emissions; and/or
 - a reduction of [X]% beyond the Target Emission Rate required by Building Regulations 2010; and/or
 - a predicted DEC (Display Energy Certificate) rating of [Y] for regulated and unregulated emissions; and/or
 - annual carbon emissions of not more than [x] kg CO₂e per [occupant / visitor / full time equivalent employee OR per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area];
- achieve the credits for operational carbon emissions [and embodied carbon] required to meet [a BREEAM / LEED / Code for Sustainable Homes rating of XXX (or equivalent)].

Embodied carbon [optional]

The design team must:

- identify the [5-10] most significant and cost-effective opportunities to reduce the embodied carbon emissions associated with the project (e.g. through leaner design, designing out waste, reusing materials, and selecting materials with lower embodied carbon over the project life-cycle);
- quantify the savings made through individual design changes; and
- report actions and outcomes as part of a Carbon Efficiency Plan.

Carbon Efficiency Plan

The design team is required to develop a Carbon Efficiency Plan (CEP) for the project (or equivalent), commencing at the concept design stage or before. The CEP should include:

- a forecast for operational energy and associated carbon emissions (including regulated and unregulated emissions), taking account of:

- building-level emissions considered within the Building Regulations asset rating (quantified using SAP (Standard Assessment Procedure)/SBEM (Simulated Building Energy Model)/DSM (Dynamic Simulation Model) tools, as appropriate to the scale and complexity of the project);
- key features that demonstrate compliance or improvement on the asset rating;
- building-level emissions for significant energy uses not considered within the asset rating, such as:

[delete as appropriate]

- external and/or sports pitch lighting;
- regional IT server racks;
- communal facilities;
- catering facilities;
- multimedia;
- etc.

- adjustments to particular values within the national calculation methodology used to establish the asset rating and forecast, taking account of:

- ramp-up of building occupancy levels
- daily and seasonal profiles of usage;
- impact of energy management practices in operation;
- performance of low carbon and renewable energy technologies;
- etc.

- a cost-effective, project-specific target which meets or exceeds regulatory requirements;
- the key design parameters by which the target will be achieved, including accepted performance tolerances and verification procedures;
- actions to be taken in design, equipment specification, construction, commissioning and post-completion to reduce carbon emissions and ensure effective implementation (with clearly identified responsibilities of relevant parties), including actions to:

- reduce the building's energy requirements;
- source low carbon energy;
- ensure effective commissioning during pre-handover, occupation and aftercare;
- raise awareness and educate building users about carbon efficiency through, for instance, a building users' guide and occupant induction sessions; and
- enable the effective monitoring of actions to reduce operational carbon (e.g. additional sub-metering or a building management system).

Potential actions should be identified, highlighting and prioritising those providing the most significant benefit.

[Optional for embodied carbon:]

- identify, quantify and select the most significant and cost-effective actions to reduce embodied carbon, including:

- selecting alternative materials;
- reducing the quantity of materials required;
- designing out waste and reducing wastage rates;
- selecting materials with longer life expectancy;
- alternatively sourcing and/or transporting products to site;
- increasing recovery and reuse of materials (reclaimed and higher recycled content); and

- information on the data and evaluation method used for embodied carbon to inform future assessment by our organisation].

Reporting

The design team will include the Carbon Efficiency Plan (CEP) [together with supporting carbon/energy calculations and energy/carbon models] within both Scheme and Detailed design reports [*or comparable documents as appropriate*] for client RIBA Stage and/or project Gateway reviews and for incorporation in documents used for contractor tendering.

The design team will provide projected financial, carbon and energy savings and associated financial costs from going beyond the minimum requirement for the project [and, if appropriate, the contribution to meeting the project's target environmental rating for BREEAM or the Code for Sustainable Homes or other targets];

The design team will ensure requirements are applied and clearly communicated to relevant contractors and subcontractors. In particular, the design team will define key features demonstrating compliance or improvement on applicable laws (including the Building Regulations) [including any defined levels of performance for construction components, central plant and equipment, or specifications to be used for subsequent fit-out of tenanted areas].

The design team will submit evidence that the minimum requirements and any other measures specified in the CEP have been implemented. This may take the form of certified post-construction environmental and carbon ratings for the building or evidence that components meeting the intended standards have been installed and appropriately commissioned."

5.0 Build and major refurbishment

5.1 Introduction

The wording below can be used when procuring a contractor. Depending on the procurement route, the contractor might already have been appointed and involved in the pre-construction activities. In such cases, the targets will have been set at an earlier stage using 'Action 2C' model wording. Where the contractor's appointment includes design responsibility, then appropriate wording from Actions 2A to 2C should be incorporated.

Irrespective of the procurement route adopted, the following model wording can be inserted in Pre-Qualification Questionnaires (PQQs), Invitation to Tender (ITT) documents and works contracts¹⁹.

The approach proposed here is in line with JCT guidance ("Building a Sustainable Future Together", 2009, <http://www.jctltd.co.uk>) which advises that "*The specific and detailed sustainability requirements should be set out in the contract documentation [i.e. preliminaries, preambles, specification, or schedule specifically prepared for the project], but if users prefer these can be set out in a schedule to the contract conditions*".

5.2 Key opportunities and decisions

The procurement process should select a contractor (and their supply chain) who is capable of achieving the carbon efficiency targets set out in the CEP (Carbon Efficiency Plan). The contractor should be engaged early on where possible²⁰, and given an opportunity to review the CEP to identify any issues and suggest alternative solutions. In their operations on site, the contractor should employ low-carbon construction methods (as outlined in the work of the Strategic Forum for Construction Carbon sub-group²¹).

5.3 KPIs, targets, roles and responsibilities

Roles	Responsibilities
<ul style="list-style-type: none">Procurement manager	<ul style="list-style-type: none">To procure a contractor with suitable skills and experience in cost-effectively improving carbon efficiencyTo set project-specific requirements on the contractor to reduce operational carbon and (optionally) embodied carbon
<ul style="list-style-type: none">Contractor	<ul style="list-style-type: none">To deliver a carbon-efficient building in accordance with the design and CEPTo use carbon-efficient construction methodsTo contribute cost-effective solutions that reduce the embodied carbon content and the operational carbon emissionsTo prepare if requested a Building Users' Guide that supports the aims of the CEP by helping occupants to increase carbon efficiency
<ul style="list-style-type: none">Client (or Technical Adviser where appointed) – with input from the design team as appropriate	<ul style="list-style-type: none">To brief the contractor on the carbon targets upon appointmentTo review and comment on the CEP pre- and post-construction

¹⁹ Under management contracts procurement, the client should ensure the management contractor cascades requirements down to works contractors. Under construction management procurement, the client should ensure requirements are also placed on specialist contractors.

²⁰ For guidance on early contractor engagement, see WRAP's Early Contractor Procurement Guidance at: http://www.wrap.org.uk/downloads/2010_09_02_Early_contractor_procurement_guidance_FINAL.c272ebcc.9728.pdf

²¹ <http://www.strategicforum.org.uk/carbon.shtml>

KPIs

- Operational carbon:
 - annual kg CO₂e per occupant / visitor / full time equivalent employee OR per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area;
 - annual kWh per occupant / visitor / full time equivalent employee OR per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area;
 - EPC rating of [X];
 - predicted DEC rating of [Y];
- [*Optionally*] Embodied carbon:
 - reduction in kgCO₂e/m²

Targets

- Achieve a minimum design outcome for predicted operational carbon emissions at building level:
 - an EPC rating of [x] for regulated emissions; and/or
 - a reduction of [x]% beyond the Target Emission Rate required by Building Regulations 2010; and/or
 - a predicted DEC of [y] for regulated and unregulated emissions; and/or
 - annual emissions of no more than [x] kg CO₂e per occupant / visitor / full time equivalent employee or per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area.
- [*Where applicable*] Achieve the credits for operational carbon emissions [and embodied carbon] required to meet a BREEAM / LEED / Code for Sustainable Homes rating of XXX (or equivalent).
- [*Optionally*] Each project implements at least [five] of the most significant cost-effective opportunities to reduce its embodied carbon emissions.

5.4 Procurement clauses

5.4.1 Action 3A: Contractor tendering

Pre-Qualification Questionnaire (PQQ) and Invitation to Tender (ITT)

PQQ questions

These questions probe the general capability of a contractor to review, optimise and implement the proposed design solution for carbon efficiency.

"As part of our commitment to reducing resource use in all of our developments and cutting the associated costs, we require all new build and refurbishment projects to pursue carbon efficiency. This involves reducing as-designed and as-built operational carbon impacts [and the embodied carbon associated with the selected construction materials].

Specific targets for this project are to [*insert relevant targets from Project Brief*]. Further detail is provided in the Project Brief.

1. Detail your understanding, experience and achievements in delivering cost-effective solutions that reduce the consumption of heat and power in buildings and associated operational carbon emissions²².
2. Detail your understanding and experience in developing a Carbon Efficiency Plan (or equivalent) to provide a robust forecast of carbon emissions together with defined and costed proposals for achieving improved standards of carbon efficiency without compromising value for money.
3. [*Optionally*] Detail your understanding, experience and achievements in the use of cost-effective construction solutions with reduced embodied carbon.
4. [*Optionally*] Detail your approach to reducing carbon emissions associated with the construction phase.

An ideal PQQ response would provide the following details:

- evidence of how the bidder has previously constructed more energy-efficient building solutions or installed more energy-efficient plant and equipment and low carbon and renewable technologies;
- an outline of their proposed approach to planning for carbon efficiency, and ability to address the areas listed in the Project Brief;
- consideration of the links between carbon efficiency and other specific project requirements, such as a BREEAM / LEED / Code for Sustainable Homes requirement, or planning conditions for carbon or renewable energy;
- (*optionally*) evidence of how the bidder has previously used construction solutions which reduce embodied carbon, including those that involve less materials, materials with lower embodied carbon, less waste generation or increased reuse of waste materials; and
- (*optionally*) evidence of the bidder's approach to reducing carbon emissions associated with the construction process itself.

ITT wording

These clauses ask contractors to explain the steps they will take on the specific project to review, optimise and implement the proposed design solution for carbon efficiency. (Where the contractor will have design responsibility and develop the Carbon Efficiency Plan themselves, use wording from Actions 2a/2B instead.)

"As part of our commitment to reducing resource use in all of our developments and cutting the associated costs, we require all new build and refurbishment projects to pursue carbon efficiency. This involves reducing as-designed and as-built operational carbon impacts [and the embodied carbon associated with the selected construction materials].

²² The Regulations contain an exhaustive list of references or evidence that potential contractors can be required to provide to prove their technical or professional ability (Regulation 25 of the Public Contracts Regulations 2006). The evidence requested must only relate to the specific contract itself – not to the operation of the contractor's whole business

You will be expected to take ownership of the Carbon Efficiency Plan (CEP) developed by the design team, finalise an agreed approach and manage its implementation.

Please describe your approach to refining and implementing the CEP for this project, including:

1. any foreseen difficulties in achieving the required targets and complying with the specified actions;
2. any value for money opportunities to further enhance performance; and
3. your proposals for ensuring and demonstrating that the completed building complies with the targets and actions agreed in the finalised pre-construction CEP."

An ideal ITT response would provide the following details:

- a commitment to delivering the CEP and achieving the targets contained within;
- constructive commentary on the design-stage CEP together with proposals for improving performance and/or value for money;
- a clear plan for owning, managing and delivering the CEP, which should include review of the plan, finalising the specifics as a pre-construction CEP and incorporating the requirements into the appointment of appropriate subcontractors; and
- information on how and when quality assured information will be provided to the client and their representatives to demonstrate the CEP has been implemented.

5.4.2 Action 3B: Contractor appointment

The approach recommended here is to include a high-level requirement in the main construction contract, with more detailed information included in the contract preliminaries.

Main Construction Contract (general conditions)

This clause should be inserted into the main contract. It could form part of a broader requirement to work in accordance with the Employer's objectives for 'resource efficiency' or 'sustainable construction', provided the requirements are clearly defined (e.g. in the Project Brief).

"The Contractor and supply chain shall carry out and complete the works in compliance with the Employer's objectives for carbon efficiency."

Preliminaries

These clauses set out the contractor's responsibilities for achieving and reporting carbon efficiency.

"As part of our commitment to reducing resource use in all of our developments and cutting the associated costs, we require all new build and refurbishment projects to pursue carbon efficiency. This involves reducing as-designed and as-built operational carbon impacts [and the embodied carbon associated with the selected construction materials].

Targets for operational carbon

We endorse the principle of going beyond the minimum requirements of applicable laws (including the Building Regulations), where cost effective. This project must:

- achieve our minimum design requirements for [regulated and unregulated] operational carbon emissions of: [delete as appropriate]
 - an EPC (Energy Performance Certificate) rating of [X] for regulated emissions; and/or
 - a reduction of [X]% beyond the Target Emission Rate required by Building Regulations 2010; and/or
 - a predicted DEC (Display Energy Certificate) rating of [Y] for regulated and unregulated emissions; or
 - annual carbon emissions of not more than [x] kg CO₂e per [occupant / visitor / full time equivalent employee OR per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area];

- achieve the credits for operational carbon emissions [and embodied carbon if desired] required to meet [a BREEAM / LEED / Code for Sustainable Homes rating of XXX (or equivalent)].

Embodied carbon [*optional*]

The contractor must:

- implement the [5-10] most significant and cost-effective opportunities to reduce the embodied carbon emissions associated with the project (e.g. through leaner design, designing out waste, reusing materials, and selecting materials with lower embodied carbon over the project life-cycle) as set out in the the Carbon Efficiency Plan for the project; and
- report actions and outcomes as part of the Carbon Efficiency Plan.

Actions

Specific actions by which our requirements for carbon efficiency will be achieved are detailed in the project Carbon Efficiency Plan (CEP). The contractor will:

- review and finalise the CEP, ensuring the above targets can be achieved as a minimum;
- ensure the completed construction is in line with the actions set out in the finalised CEP, including:
 - achievement of stated design standards such as fabric insulation, thermal bridging or air tightness requirements;
 - design and installation of energy-efficient building products, plant and equipment;
 - design and installation of low carbon or renewable energy technologies;
 - measures to minimise energy wastage in operation, by enabling effective facilities management and performance reporting;
 - [optionally] actions to reduce embodied carbon within the selected constructed solutions; and
 - [optionally] actions to reduce carbon emissions associated with the construction process.
- provide evidence to demonstrate the effective implementation of the CEP, including:
 - invoices /delivery records for products meeting the specified levels of carbon efficiency;
 - photographic or other evidence (e.g. inspection records from the Employer’s Agent) to demonstrate installation and effective operation of the specified fittings and technologies;
 - commissioning records of specified whole-building operational performance; and
 - certified achievement of credit requirements to meet the targeted environmental rating assessment.

Completion and handover

Upon completion of the project, the contractor will be required to provide necessary data and documentation (e.g. for products or equipment installed, results of tests conducted etc.) to the client or occupier.

5.4.3 Action 3C: Subcontractor appointment

Where a subcontractor’s activities will have an influence on the delivery of the CEP, then it is important for the Principal Contractor to require their suppliers to work in accordance with the CEP (whether for new build or refurbishment). This might be limited to the procurement and installation of plant and equipment meeting a specified level of performance. In other cases, their role might involve ensuring the commissioning of products to meet a performance standard.

The relevance of procurement requirements to specific trade packages will vary with the actions that are contained in the CEP. Therefore the procurement wording below should be tailored as indicated.

“All subcontractors are required to work in accordance with the Carbon Efficiency Plan (CEP) for this project. The CEP specifies the performance standards for the operational carbon emissions from the consumption of heat

and power. The CEP also details specific actions to reduce the lifetime carbon emissions from the building [and selected construction solutions with lower embodied carbon].

Specific actions applicable to [Subcontractor name] are:

- [insert implementation actions]; and
- [insert reporting actions].

[Subcontractor name] will contribute to the achievement of the above actions by ensuring appropriately performing products are used, correctly installed, tested and reported on.

Upon completion of the project, the subcontractor will provide data and documentation (e.g. for products or equipment installed) to the contractor for inclusion in the handover to the client or occupier.

5.4.4 Action 3D: Post-construction review and handover

At this stage the client, or their representative, should be satisfied the work has been conducted in line with the requirements of the CEP. As part of the handover / project completion process, post-construction testing should be carried out to confirm that the finished building meets the performance requirements. The project team should submit evidence that the requirements and measures specified in the CEP have been implemented; for example, certified post-construction environmental and carbon ratings for the building or evidence that components meeting the intended standards have been installed and appropriately commissioned. Payments or penalties could be linked to evidence of satisfactory performance.

6.0 Occupation

6.1 Introduction

The behaviour and activities of occupiers can significantly increase the energy consumption of a building. Accurately predicting how the occupants will behave is therefore important; however, this is often regarded as outside the scope of the project. Building Regulation calculation tools make use of defaults (the NCM profiles) that usually go unquestioned on each individual project.

Various schemes have emerged to incentivise earlier communication between the project team and occupants, including:

- Green Lease Agreements (between landlords and tenants);
- Building User Surveys (BUS) for existing buildings to identify what is liked and any problem areas disliked; and
- the Soft Landings Framework²³ for an extended handover of a new building to its occupants.

The development of a CEP could support each of these.

The Soft Landings Framework has been developed to help project teams avoid the most common technical problems when a building is commissioned and initially used and to ensure occupants make the best use of their building following handover, so as to reduce the gap between design intent and performance in use. The Soft Landings approach applies to all aspects of a building's performance, including energy use and carbon emissions, and aims to transfer information from the project team to the occupiers and facilities managers and capture the learning from each project. A CEP provides a similar framework and can therefore be integrated within a wider Soft Landings approach. The Soft Landings approach also promotes retaining the design team and maintaining their involvement in a project until the building's required performance levels have been established in operation. If you wish to use the Soft Landings Framework approach in your project, you should state this in the procurement wording²⁴.

In the situation of an owner-occupied development, the model wording for a Facilities Management Brief under Action 1B could be adapted to suit. In situations where the development is not for an owner-occupier but the occupier is provided opportunity to set out their expectations for the building's low carbon performance, the wording in Action 4A below could be used.

²³ <http://www.bsria.co.uk/services/design/soft-landings/>

²⁴ *BSRIA are the industry body promoting Soft Landings. Their advice is to set aside 0.1 to 0.25% of the contract value for the additional requirements introduced by Soft Landings: in particular, extended aftercare following the building hand-over and fine-tuning of the building systems and post-occupancy evaluation by the project team. The payback on this investment is reduced energy costs, reduced FM and more satisfied and productive building users.*

6.2 Key opportunities and decisions

The occupier should clearly outline their expectations and objectives with regard to carbon efficiency when selecting a building. This guide provides a variety of potential requirements.

When a suitable building is found, the occupier and landlord should then agree specific lease terms which will ensure carbon efficiency. This is often referred to as a 'green lease'. Many forms of green lease exist; key elements will include ensuring the occupier is not prevented by inflexible standard leasing terms from undertaking sensible carbon efficiencies and, conversely, that the landlord will be able to correct carbon inefficiencies that impact on the building's carbon performance.

The occupier should recognise that, whilst they can specify a certain standard of building and of building management, the behaviour of their own staff will significantly influence the carbon efficiency of the building in use. The clauses below will help ensure that the asset manager and the facilities manager play their part, but the occupier should also give clear direction to their staff as to how the building should be used, and introduce appropriate behaviour change measures to engage staff in helping to achieve their policy and targets.

6.3 KPIs, targets, roles and responsibilities

Roles	Responsibilities
<ul style="list-style-type: none"> ■ Occupier 	<ul style="list-style-type: none"> ■ To set clear carbon efficiency objectives when leasing a building ■ To play their part in ensuring staff use the building appropriately
<ul style="list-style-type: none"> ■ Owner 	<ul style="list-style-type: none"> ■ To provide a building which meets the prospective occupier's criteria
<ul style="list-style-type: none"> ■ Asset manager 	<ul style="list-style-type: none"> ■ To report performance to the owner/occupier on a periodic (e.g. quarterly) basis, or as required to meet legal (e.g. CRC-EES) and other reporting requirements ■ To provide to the owner the business case for any actions to reduce carbon emissions
<ul style="list-style-type: none"> ■ Facilities manager 	<ul style="list-style-type: none"> ■ Monitor plant and report to the asset manager as to whether plant is performing to standard norms ■ To measure and collate performance on a periodic (e.g. quarterly) basis and liaise with the asset manager to produce performance reports for the owner/occupier
KPIs	
<ul style="list-style-type: none"> ■ Operational carbon: <ul style="list-style-type: none"> ○ annual kg CO₂e per occupant / visitor / full time equivalent employee OR per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area; and/or ○ annual kWh per occupant / visitor / full time equivalent employee OR per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area; ■ Consumption [<i>and if appropriate</i>, generation] of each fuel type in kWh per [m² / let floor / occupant / visitor] per year ■ Net cost of fuel, broken down by type, in £ per [m² / let floor / occupant / visitor] per year ■ CO₂e emissions factors for each fuel type as per Building Regulations for comparison against design predictions ■ % reduction in fuel consumption, broken down by type, relative to baseline year [x] 	
Targets	
<ul style="list-style-type: none"> ■ Meet or exceed an operational target for each building of: <ul style="list-style-type: none"> ○ annual carbon emissions of not more than [x] kg CO₂e per occupant / visitor / full time equivalent employee OR per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area; and/or ○ annual energy consumption of not more than [x] kWh per occupant / visitor / full time 	

equivalent employee OR per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area; and/or

- a DEC rating of [Y]; and/or
- [x]% reduction in energy/carbon emissions relative to performance in 20[xx].

6.4 Procurement clauses

6.4.1 Action 4A: Occupier's performance requirements

"As part of our commitment to occupying buildings with low environmental impact, we require reduction in operational carbon and the associated consumption of heat and power.

Our specific targets for occupied buildings are [insert relevant targets from corporate policy]. Further detail is provided in [insert reference to corporate policy]. In particular, we look to occupy buildings for which a Carbon Efficiency Plan (or equivalent) has been developed to include:

- a building-specific target for reducing carbon emissions that meets or exceeds our minimum requirement;
- a forecast of operational carbon emissions, taking account of:
 - building-level emissions considered within the Building Regulations asset rating, i.e. space heating, water heating, space cooling, ventilation, lighting and low carbon and renewable energy technologies;
 - key features that demonstrate compliance or improvement on the asset rating;
 - building-level emissions for the following features not considered within the asset rating (for which adequate energy sub-metering is expected to be in place):
 - [delete as appropriate]
 - external and/or sports pitch lighting;
 - regional IT server racks;
 - community used facilities;
 - catering facilities;
 - multimedia
 - etc.
 - planned cost-effective actions to:
 - maintain the facilities (building, plant and equipment, including controls and monitoring systems) so that they work safely and in line with their design performance;
 - reduce carbon emissions and energy consumption through management and maintenance of facility operations and building, plant and equipment;
 - reduce carbon emissions and energy consumption through targeted replacement or retrofitting of building, plant and equipment;
 - reduce carbon emissions and energy consumption by taking actions to change the behaviour of occupants;
 - [include if appropriate] ensure energy-using technologies are maintained and serviced by appropriately qualified professionals in line with the manufacturer's instructions; and
 - monitor energy consumption and associated carbon emissions in line with the metrics described below.
- reporting of performance on a [monthly/quarterly/annual] basis, against the following key performance indicators:
 - [include as appropriate]
 - operational carbon:
 - annual kg CO₂e per occupant / visitor / full time equivalent employee OR per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area;
 - annual kWh per occupant / visitor / full time equivalent employee OR per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area;
 - consumption [and if appropriate, generation] of each fuel type in kWh per [m² / let floor / occupant / visitor] per year;
 - net cost of fuel, broken down by type, in £ per [m² / let floor / occupant / visitor] per year;
 - CO₂e emissions factors for each fuel type as per Building Regulations for comparison against design predictions; and

- % reduction in fuel consumption, broken down by type, relative to baseline year [x].

The facilities manager is required to report performance of the building and plant to the asset manager on a [monthly/quarterly/annual] basis against the KPIs stated above, and to provide appropriate evidence. The facilities manager is required to make recommendations to the asset manager on any major works or replacement to improve carbon efficiency.

The asset manager is required to liaise with the facilities manager to assess the business case for action (replacement, refurbishment etc) to improve carbon efficiency. The asset manager should ensure we receive accurate and useful information on current performance and plans for improvements.

As part of the handover / project completion process, the asset manager/facilities manager should ensure the project team provide evidence that the minimum requirements and any other measures specified in the CEP have been implemented. This may take the form of certified post-construction environmental and carbon ratings for the building or evidence that components meeting the intended standards have been installed and appropriately commissioned.

7.0 Maintenance and management

7.1 Introduction

Facilities management organisations are responsible for management and maintenance of the building. In this role, they are vital to ensuring the carbon efficiency of the building in use. They can help to ensure that the building meets its potential carbon efficiency by regularly monitoring and reporting on the performance of the building, as well as advising on opportunities for improvements over the life of the building.

This model wording addresses the selection and appointment of facilities management contractors. The wording only considers operational carbon, as works large enough to warrant consideration of embodied carbon (e.g. façade upgrade) are defined as a major refurbishment (refer to Sections 3 to 5).

7.2 Key opportunities and decisions

The facilities manager should receive a CEP (Carbon Efficiency Plan, or its equivalent, such as an energy management plan) from the building owner/manager upon taking up the role – or, where a CEP does not exist, prepare one. The facilities manager should review the plan so that they are aware of the building’s targeted operational carbon efficiency. At this point, they should advise on any changes or alterations to the targets set out in the plan.

Over the life of the building, the facilities manager should monitor and report regularly on the operational carbon efficiency. They should also provide suggestions for improvement. When an issue or opportunity arises, the facilities manager should calculate the business case for action based on the estimated capital and lifecycle costs, reduction in carbon emissions, and balance of costs and benefits between the parties.

7.3 KPIs, targets, roles and responsibilities

Roles	Responsibilities
<ul style="list-style-type: none"> ■ Owner/manager/occupier 	<ul style="list-style-type: none"> ■ To set clear carbon efficiency objectives ■ To require regular reporting on operational carbon efficiency ■ To review performance against the CEP regularly ■ To play their part in ensuring staff use the building appropriately
<ul style="list-style-type: none"> ■ Facilities manager 	<ul style="list-style-type: none"> ■ To review the commissioning records to ensure building systems were accurately set-up and to identify the timescales for re-commissioning ■ To ensure excess carbon is not emitted because of poor maintenance or management ■ To train FM staff as necessary to enable them to effectively undertake carbon efficiency duties ■ Ideally, to undertake periodic Post Occupancy Evaluation studies of the building’s performance and the causes behind any anomalies ■ To report on performance to the property manager / landlord / occupier ■ To advise on opportunities to reduce carbon emissions through retrofit measures, bringing forward replacement of poorly performing plant and equipment, and influencing the behaviour of building occupants
KPIs	
<ul style="list-style-type: none"> ■ Operational carbon: <ul style="list-style-type: none"> ○ annual kg CO₂e per occupant / visitor / full time equivalent employee OR per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area; and/or ○ annual kWh per occupant / visitor / full time equivalent employee OR per m² Net Lettable Area / 	

Treated Floor Area / Gross Internal Floor Area;

- consumption [and if appropriate generation] of each fuel type in kWh per [m² / let floor / occupant / visitor] per year;
- net cost of fuel, broken down by type, in £ per [m² / let floor / occupant / visitor] per year;
- CO₂e emissions for the aggregated consumption of fuel (for comparison against design predictions);
- % reduction in fuel consumption, broken down by type, relative to baseline year [x].

Targets

- Meet or exceed an operational target for each building of:
 - annual carbon emissions of not more than [x] kg CO₂e per occupant / visitor / full time equivalent employee OR per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area; and/or
 - annual energy consumption of not more than [x] kWh per occupant / visitor / full time equivalent employee OR per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area; and/or
 - a DEC rating of [Y]; and/or
 - [x]% reduction in energy/carbon emissions relative to performance in 20[xx].

7.4 Procurement clauses

7.4.1 Action 5A: Facilities manager tendering

Pre-Qualification Questionnaire (PQQ) and Invitation to Tender (ITT)

PQQ questions

These questions probe the general capability of a facilities manager to prepare and implement a plan for operational carbon efficiency.

"As part of our commitment to reducing resource use in all of our developments and cutting the associated costs, we require the facilities management of our buildings to pursue carbon efficiency with respect to the consumption of heat and power and associated carbon emissions.

Our targets for operational carbon emissions in [*insert building type / our portfolio*] are [*insert relevant targets from Facilities Management Brief*]. Further detail is provided in the Facilities Management Brief.

1. Detail your understanding, experience and achievements in cost-effectively reducing the consumption of fuel and power in buildings²⁵.
2. Detail your understanding and experience in developing Carbon Efficiency Plans (or equivalent) that provide a robust forecast of energy consumption and associated carbon emissions together with defined and costed proposals for achieving performance improvements.
3. Detail your understanding, experience and achievements in motivating building occupants to reduce energy consumption.
4. [*If relevant*] Detail your understanding and experience in managing low carbon and renewable energy technologies so they operate efficiently and safely.

An ideal PQQ response would provide the following details:

- evidence of having reduced energy consumption and associated carbon emissions using effective management, replacement / retrofitting / post-occupancy evaluation and behavioural change programmes;

²⁵ The Regulations contain an exhaustive list of references or evidence that potential suppliers can be required to provide to prove their technical or professional ability (Regulation 25 of the Public Contracts Regulations 2006). The evidence requested must only relate to the specific contract itself – not to the operation of the supplier's whole business

- evidence of having prepared improvement strategies and cost-benefit analysis in relation to energy and carbon efficiency; this might include development and management of certified processes on ISO14001, BS EN 16001, Carbon Trust Standard or similar; and
- [*if question 4 is used*] evidence of understanding the key management requirements of low carbon and renewable energy technologies, ideally with examples of proven success.

ITT wording

These clauses ask facilities managers to explain how they will forecast end-use energy consumption and associated carbon emissions, identify and prioritise reduction measures, assess the net costs and benefits of improvements and report on their effectiveness.

"As part of our commitment to reducing resource use in all of our developments and cutting the associated costs, we require the facilities management of our buildings to pursue carbon efficiency with respect to the operational carbon emissions and the associated consumption of heat and power.

Our targets for operational carbon emissions in [*insert building type / our portfolio*] are [*insert relevant targets from Facilities Management Brief*]. Further detail is provided in the Facilities Management Brief.

Please describe your approach to:

1. helping us achieve our target for operational carbon emissions; and
2. developing a Carbon Efficiency Plan (CEP, or equivalent) in line with the requirements set out in the Facilities Management Brief.

Please identify any factors you believe to be significant to the cost-effective achievement of the targets set for operational energy and carbon."

An ideal ITT response would provide the following details:

- a commitment to developing and implementing a CEP to achieve the client's targets;
- commentary on the key issues to be addressed, which could include identifying the major consumers of energy and emitters of carbon and suggesting measures by which energy could be conserved or low carbon fuel sources used;
- evidence of a clear method for prioritising and targeting actions so that quick win opportunities are secured and a focused medium-term plan is put in place to implement efficiency measures at the appropriate time in the building's maintenance cycle; and
- information on how and when information will be provided to the client and their representatives to demonstrate the CEP has been implemented in accordance with the agreed targets.

7.4.2 Action 5B: Facilities manager appointment

"The facilities manager will work with [*company name, department*] to plan and implement a suitable Carbon Efficiency Plan (CEP, or equivalent) and to report on performance in line with the targets therein. The facilities manager will review and update the plan in accordance with the timetable specified in the plan, to ensure the availability of up-to-date information.

The facilities manager will be required to:

- measure and report performance on a periodic (e.g. quarterly) basis or as required to meet legal (e.g. CRC Energy Efficiency Scheme) and other reporting requirements – reports should be supported by evidence in the form of utility bills and should present:
 - the energy consumption in kWh split by fuel source for the areas for which the facilities manager has responsibility;
 - the carbon emissions associated with this energy consumption based on the carbon conversion factors published by DECC (Department of Energy and Climate Change) for use in CRC reporting;
 - the floor area / occupants / visitors / full time equivalent employees for the areas to which the facilities management contract applies; and
 - overall energy and carbon efficiency in the form of annual kWh and kg CO₂e per occupant / visitor / full time equivalent employee or per m² Net Lettable Area / Treated Floor Area / Gross Internal Floor Area;

- provide the business case for any actions to reduce carbon emissions – based on the estimated capital and lifecycle costs of the recommended works, the value of reduced carbon emissions and the allocation of costs and benefits between parties.

Planning

The facilities manager is required to implement or (where none currently exists) develop a Carbon Efficiency Plan (CEP) for the project (or equivalent), commencing at handover and occupation, which should include:

- a forecast for operational energy and associated carbon emissions, to provide a baseline for assessment of savings;
- targets for reducing operational energy and associated carbon emissions – which should be SMART (i.e. Specific, Measurable, Achievable, Relevant and Time-based);
- management actions and investment priorities for reducing cost and improving carbon efficiency, e.g.:

[delete as necessary subject to the scope of the FM contract]

- additional metering to enable effective reporting and management;
- regular energy profile audits to establish normal and abnormal operating behaviour, quantify energy inefficiencies and identify priorities for remedial work;
- switching to low and zero carbon technologies and fuel sources;
- encouraging responsible energy use by occupants; and
- *[include if appropriate]* agreeing capital investment with other parties (e.g. landlord or asset manager).

- a timetable for reviewing and updating the CEP to reflect trends in actual performance and availability of better technologies.

Implementation

The facilities manager is required to implement cost-effective initiatives in line with the agreed CEP:

[delete as necessary subject to the scope of the FM contract]

- maintain the facilities (building, plant and equipment, including controls and monitoring systems) so that they work safely and in line with their design performance;
- monitor energy consumption and associated carbon emissions in line with the metrics described above;
- reduce carbon emissions and energy consumption through management and maintenance of facility operations and building, plant and equipment;
- reduce carbon emissions and energy consumption through targeted replacement or retrofitting of building, plant and equipment;
- reduce carbon emissions and energy consumption by taking actions to change the behaviour of occupants;
- ensure energy-using technologies are maintained and serviced by appropriately trained and qualified professionals in line with the manufacturer's instructions.

Reporting

The facilities manager is required to report performance of the building and plant to the asset manager on a [monthly/quarterly/annual] basis against the targets stated above, provide appropriate evidence and identify any issues. The facilities manager is also required to make recommendations to the asset manager on any major works or replacement to improve carbon efficiency.

Reacting

The facilities manager is required to:

- check for, and respond promptly to, identified underperformance or malfunctions;
- *[include if appropriate]* provide evidence and support on negotiations for capital investment with other parties (e.g. landlord or asset manager); and
- update the CEP to take account of the actual performance of facilities, changes in occupier requirements and the market drivers for carbon savings, and the availability of new systems or low carbon or renewable technologies.

Revisions to the CEP must be agreed in writing before implementation."

Where the appointed FM contractor needs to appoint a sub-contractor to undertake work associated with the delivery of the CEP, the model wording included in Section 5 (Action 3C) can be used.

Appendix 1: Key regulations and standards in relation to embodied and operational carbon

Embodied carbon

The embodied carbon content of construction materials is less regulated than the operational carbon of buildings. However, as the operational carbon emissions decrease in future, it will become increasingly important to reduce embodied carbon. The carbon impact of materials should therefore be considered alongside operational carbon. For infrastructure projects, embodied carbon may be the major carbon impact.

There are existing datasets, tools and approaches to calculating embodied carbon. Several of these are listed towards the end of Appendix 4. These have been developed either as in-house consultancy tools or to prompt wider discussion within the industry. However, it is essential that any evaluations undertaken are carefully documented to ensure it is clear what dataset and scope was used. This will enable benchmarking and comparison between analyses which have used the same dataset and scope.

■ **European CEN TC350**

CEN TC350 will define a harmonised method for building level assessment of construction products, although evaluation of the results will remain outside the standards. Countries or approved organisations will be able to decide which indicators and weighting to use, as well as how the building life cycle will be considered; for instance, the number of years for maintenance and refurbishment considerations.

Once the CEN TC350 standards are approved, manufacturers should only need to undertake one LCA (Life Cycle Assessment) study to produce an Environmental Product Declaration (EPD), which takes account of greenhouse gas emissions relevant to their product. A verified EPD can be used as a source for embodied carbon data, although it is likely that the same product will require a different EPD for each region where it is produced, to account for regional variations in transportation, construction practice, maintenance and disposal methods.

■ **Code for Sustainable Homes (CSH) /BREEAM /LEED**

The CSH (for domestic buildings) and BREEAM (for non-domestic buildings) are the UK's leading assessment methodologies for holistically sustainable buildings. LEED is the American equivalent to BREEAM. LEED is relevant to the UK as some international organisations are using it to benchmark their building portfolio.

It is mandatory for new homes to declare their CSH rating (even if unrated), with a higher rating required for homes that receive funding from the HCA (Homes and Communities Agency). The Common Minimum Standards for public sector procurement of the built environment require BREEAM Excellent for new build and BREEAM Very Good for refurbishment²⁶. It is not mandatory for private-sector non-domestic buildings to have a BREEAM rating. However, local authority planning departments have used CSH and BREEAM ratings as a way to stipulate higher standards of sustainability in local policies. Embodied carbon is considered implicitly by both the CSH and BREEAM when awarding credits in the 'materials' section of the assessment. Credits are awarded on the basis of each material's rating in the BRE's Green Guide to Specification, which considers 'cradle to cradle' embodied carbon as part of a Life Cycle Assessment across a range of environmental impacts.

■ **Climate Change Levy and Climate Change Agreements**

Industrial energy users are subject to the Climate Change Levy (CCL), a tax on energy use introduced in 2001. The CCL aims to incentivise industry to improve energy efficiency and move to low carbon energy.

²⁶ http://www.ogc.gov.uk/documents/Common_Minimum_Standards_PDF.pdf

The tax is offset at a national level by reductions in National Insurance. In return for meeting targets on emissions, large industrial groups have reached Climate Change Agreements (CCA) to reduce their CCL obligations. Over time, such action will reduce the embodied carbon of construction products such as steel and cement by reducing carbon emissions at the manufacturing stage.

Operational carbon

■ **EU Energy Performance of Buildings Directive (EPBD)**

The EPBD was introduced in 2003. It requires all buildings to be 'nearly zero carbon' by 2020, which has driven the UK's goals of zero carbon homes by 2016 and zero carbon non-domestic buildings by 2019. The EPBD requirements include for buildings undergoing major renovation.

A revised version of the EPBD is currently under consultation. The text contains some relevant items that should be implemented by January 2013:

- a new requirement for a methodology for calculating and comparing the lifecycle costs of different levels of operational energy performance;
- minimum energy performance requirements for new buildings to apply also to all major renovations; and
- a new requirement for transparent penalties for non-compliance, which must be 'effective, proportionate and dissuasive'.

■ **Building Regulations – the conservation of fuel and power (Part L for England and Wales, Part J for Scotland, Part F for Northern Ireland)**

These set out the technical requirements for a building to meet a minimum standard of performance suitable for planning application. Compliance has to be demonstrated against a series of criteria by submission of a BRUKL report, which includes the building's associated emissions of carbon and the EPC (Energy Performance Certificate – reviewed further below).

The 2010 Part L for England and Wales introduces some items relevant to procurement. In particular:

- A firm requirement for a design stage calculation to be submitted to the Building Control Body in addition to an 'as-built' version on building completion. Therefore any significant variations to the energy strategy between design and completion have to be managed in a controlled manner.
- The approved calculation methodology/software will highlight key features important to the energy strategy. These will be subjected to additional scrutiny by the building control officer during building completion, to ensure the design intention was followed through in construction.
- Increased emphasis on checking the quality of the actual building (in addition to design specification) places greater responsibility on clients and principal contractors to select teams competent in delivering carbon-efficient buildings.
- 2010 Part L removes the ability to comply by using renewable energy extensively in an energy inefficient building.
- Shell and core assessments will set compliance parameters for the later fit-out to follow.

■ **EPC (Energy Performance Certificate) for buildings at the point of construction and resale**

The EPC indicates how a building's specified energy and carbon performance compares to a benchmarking standard for a compliant building of similar form and function, which within Building Regulations Part L is termed the 'notional building'. The EPC is required by the Building Control Body before they can provide the Completion Certificate. As an EPC will exist for all new buildings (and properties at the point of rental), they provide a convenient benchmark of performance. For various reasons however, the EPC does not accurately indicate the actual fuel and power consumption of the building and hence the operational carbon emissions:

- The Building Regulations do not require all heat and power demands of the building to be considered. The 'unregulated' loads can be a very significant proportion of the building's consumption; for instance, a PC for every child in a school, or multi-kilowatt machinery on a factory

floor. As well as leading to significant power consumption, these loads can further affect the building physics by producing a significant quantity of waste heat that can reduce the need for fuel into the boiler and increase the requirement for power to provide comfort and server room cooling.

- The EPC is based on the specification submitted to the Building Control Body during the building's design stage and construction stage. This raises the prospect that there will be variance between the specification and the actual build quality. Measures are being introduced into Building Regulations for additional post-construction checks such as air-tightness and co-heating tests, to confirm the as-built performance matches the specification.
- There are modelling errors inherent in the algorithms that generate the EPC. In particular, the behaviour of the human occupants of buildings is not accurately represented. For example, the EPC model might assume a window will only be opened when the air quality in a room is poor, whereas the reality is that windows are often left open all day whatever the indoor air quality, with a resulting increase in the annual requirement for heating fuel. Possibly EPCs will never be able to satisfactorily account for all the uncertainties surrounding the behaviour of people in buildings.

■ **DEC (Display Energy Certificate) for operational buildings**

The DEC provides a more accurate measure of the energy consumption and associated carbon emissions from a building in use (compared to the EPC). It is more accurate as it is based on actual meter readings.

It has been mandatory since 1st October 2008 for a DEC to be prominently displayed (e.g. at the reception desk) in every building with a total useful floor area >1,000m² occupied by a public authority or an institution providing public services. The information contained on each public sector DEC is publically available. In addition, a number of private sector organisations are commissioning consultants to generate DEC's for their building(s). Although the information will usually remain commercially confidential, the DEC is used to guide decisions on energy investment in buildings, which has always been the intended purpose. There are calls for a DEC to be mandatory for all buildings of all sizes occupied by all sectors.

■ **Consequential improvements – a sub-requirement of the Building Regulations**

Consequential improvements, which are defined in Part L2B for England and Wales, require energy efficiency improvements to be made to an existing building when significant building works take place on it. This can improve the cost-effectiveness of reducing the operational carbon emissions of a building by making use of the same contractors and exploiting the opportunity to make major improvements that might otherwise have not been made in isolation. Significant building works could include the construction of an extension or a major internal refurbishment. Suitable energy efficiency improvements could include replacement of outdated windows, a lighting system upgrade or heating and ventilation plant refit. Consequential improvements currently only apply to non-domestic buildings although they are expected to also apply to domestic buildings in future revisions of Part L1B.

■ **Onsite renewable energy policies, e.g. The Merton Rule**

The London Borough of Merton has become synonymous with the introduction of a planning requirement for all new buildings over 1,000m² to feature onsite renewable energy and low carbon technologies. The requirement was originally set as 10% of the predicted energy requirements. Many local authorities have since followed suit, using a variety of requirement terminology: "X% of predicted energy requirements"; "X% of predicted carbon requirements"; "X% of building regulated energy/carbon"; "X% of regulated and unregulated energy/carbon requirements"; etc. Typically the performance target is 10% although there are several examples of 20%. As well as directly encouraging the use of renewable energy technologies, the Merton Rule has been widely credited for indirectly promoting energy efficiency, as the cost associated with building to a higher standard of energy efficiency is often found to be less than the cost of installing additional renewable energy technologies.

■ **Code for Sustainable Homes (CSH) /BREEAM /LEED**

As mentioned before, many local authority planning departments are using CSH and BREEAM ratings as a way to stipulate higher standards of sustainability in local policies. Operational carbon is considered by both the CSH and BREEAM when awarding credits in the 'energy' section of the assessment. Credits are awarded

on the basis of the EPC (Energy Performance Certificate), although there are calls for the BRE to amend this position in light of the issues mentioned previously on EPC accuracy.

■ **CRC Energy Efficiency Scheme (CRC-EES)**

The recently introduced CRC-EES is of particular note as it is perhaps the strongest incentive in place for large organisations to implement carbon efficiency improvements to existing buildings. There are two sides to the incentive created by the CRC-EES. First, each relevant organisation has an obligation to purchase 'carbon allowances' equal to the predicted carbon emissions associated with their business operations. These allowances will be repaid to the organisation one year later (plus or minus a marginal bonus or penalty, depending on their annual performance); however, the repayment occurs after the obligated purchase of the next year's allowances. The organisation therefore has to make consideration for double the impact on cash flow, which places additional focus on what can be done to reduce the allowance payments. Second, each relevant organisation will be ranked in a publically reported league table in terms of their annual reduction in carbon emissions in comparison to others in the scheme. The indirect cost of reputational damage incurred by coming low down in the league table is thought to be incentivising organisations more than the direct costs of purchasing/recycling carbon allowances. This is particularly thought to be the case in the private sector where poor league table position could potentially lead to the loss of supply chain contracts. The CRC-EES is estimated to apply fully to 4,000 UK organisations. The first year of registration is 2010 and there are penalties for late registration. It is too early to indicate the scale of action being taken to reduce operational carbon emissions as a result of the scheme's introduction. However, there are already calls for an additional version of the CRC-EES to be introduced for Small and Medium Enterprises (SME) and ultimately for all businesses to have to monitor and pay a price for the carbon emissions for which they are responsible.

■ **BS EN 16001 – Energy Management System**

BS EN 16001 specifies the requirements for an Energy Management System (EMS) to develop and implement a policy, identify significant areas of energy consumption and target energy reduction measures. There are links between the CRC-EES and BS EN 16001. The CRC-EES rewards organisations who successfully implement 'Early Action Metrics', one of which is the creation of an EMS such as BS EN 16001. The BSI has launched a Kitemark scheme for Energy Reduction Verification in recognition of those organisations creating an effective EMS. This Kitemark can be used to gain a CRC-EES Early Action Metric.

Macro carbon efficiency

■ **Decarbonisation of the national power grid**

The National Grid supplies the vast majority of power consumed by the UK building stock. Although some buildings make use of power generation technologies installed onsite (CHP, PV, wind power, fuel cells), the overall bias for the foreseeable future will remain towards centralised power plants generating and distributing power around the country. This creates a need for the National Grid to go through a long-term programme of 'decarbonisation'; to reduce the carbon emissions that are the indirect consequence of consuming power within buildings. Decarbonisation will be the result primarily of taking polluting power stations offline and upgrading or replacing them with less polluting alternatives such as nuclear power and renewable energy. The long-term benefit of decarbonisation will be reduction in both operational carbon emissions and the embodied carbon content of construction products manufactured in facilities that draw power from the grid. However, this transition will take many years (potentially decades).

■ **EU Emissions Trading System (ETS)**

The ETS is central to the EU and UK Government's policy to reduce carbon emissions in the long-term. As a trading scheme applicable to the main energy-intensive industries – power stations, refineries and offshore, iron and steel, cement and lime, paper, food and drink, glass, ceramics, engineering and the manufacture of vehicles – the ETS has influence on approximately 50% of UK carbon emissions. Many materials used in the manufacture of construction products are supplied by companies affected by the ETS.

The objective of the ETS is to provide clear incentives for additional investment in energy efficiency and cleaner technology. This investment will lead to a reduction in carbon emissions 'upstream' of building construction, reducing the embodied carbon content of many construction products.

- **EU Industrial Emissions Directive (IED)**

The recently approved IED might lead to a reduction in both the embodied carbon content of construction products made in the EU and the ongoing operational carbon emissions from UK buildings in operation.

The most significant aspect of the IED is its integration of the Large Combustion Plant Directive and the Integrated Pollution Prevention and Control (IPPC) Directive. The IED is primarily focused on reducing emissions from the power sector of nitrogen oxide (NO_x), sulphur dioxide (SO₂) and particulates. Emissions of these gases are loosely associated with the use of fossil fuels; however, the process used to achieve the reduction often leads to increased requirement for energy. So it is uncertain if the IED will improve the carbon efficiency of the National Grid.

Appendix 2: Guidance on embodied carbon

As we reduce energy use and the consequent CO₂ emissions from our buildings, then the impacts associated with making the construction materials become more important. The CO₂ emissions associated with these materials are known as “embodied carbon”. Before Building Regulation started to reduce operational energy consumption, embodied carbon was a tiny part of the impact of a building, and research around it only started in the 1990s. But by 2016, embodied carbon will be the major source of CO₂ emissions associated with new build zero carbon housing.

In 2001, M4i estimated the typical CO₂ emissions from new build housing operational energy use to be approximately 70 kg CO₂ per m² and the embodied carbon to be 650 kg CO₂ per m²; after 60 years the embodied carbon would be around 15% of the total CO₂ emission from the house.

What is embodied carbon?

Embodied carbon is the CO₂ or total greenhouse gas emissions (CO₂e) associated with extraction and manufacturing, and sometimes from transporting, installing, maintaining and disposing of construction materials. The majority of embodied carbon is CO₂ emitted from the use of fossil fuels in extraction and manufacturing of construction materials and process emissions from manufacturing. In some measures of embodied carbon, it is only this emission of CO₂, from the “cradle to the gate”, that is calculated. However other measures can take into account other greenhouse gases such as methane, nitrous oxide and HFCs, and emissions from transport to site, and from maintenance and replacement over the building life, and from disposal methods such as incineration.

Why should we measure embodied carbon?

The UK’s targets for reducing greenhouse gas emissions are stringent – to achieve our long term target of 80% reduction in CO₂ emissions by 2050, or the short term target of 34% reduction in 10 years (2020), the construction industry cannot rely on reducing operational energy along, although this is obviously a key role it can play. Production and delivery of construction materials for the UK market is estimated to produce 46 million tonnes of CO₂ per annum²⁷. The construction products sector have responded by increasing their efforts to reduce energy use and improve logistics. A major initiative, led by WRAP, has targeted construction waste and the unnecessary use of energy to produce materials that end up in landfill. Contractors are looking at reducing energy use on site and in the transport of personnel. But building designers can also reduce the embodied carbon within buildings, alongside the operational carbon, especially when their clients encourage them, but to do so, they need to be able to measure embodied carbon, explore reduction strategies and demonstrate reductions.

How can we measure embodied carbon?

At its simplest, embodied carbon can be calculated in much the same way as building costs were calculated historically – a Bill of Quantities is linked to the embodied carbon per quantity, and the total for the building can be calculated. Now detailed Bills of Quantities are used more rarely, so quantifying the materials used in the building and linking to environmental data is not so simple – although the building cost plan contains relevant data. A number of building-level tools are already available, such as Envest2²⁸ produced by BRE, and research is ongoing worldwide to link CAD models and environmental data for materials. For example, the UK Technology Strategy Board’s Design and Decision Tools research programme²⁹ aims to produce a range of tools for the UK market, many of which will provide embodied carbon data in some way.

²⁷ *Emerging findings of the Low Carbon Innovation and Growth Team, 2010*

²⁸ www.bre.co.uk/envest

²⁹ <http://www.innovateuk.org/content/press-release/designing-tomorrows-greener-buildings-.ashx>

The two main considerations with regard to measuring embodied carbon are closely linked – the first is the scope of the data, and the second is the use of consistent data:

- Cradle to gate data are most easily available at product level. Using data at this level will ignore any differences over the life of the building, for example between two windows which may have different expected lives in the building or maintenance schedules such as painting.
- Including the impacts of transport is most important for high tonnage materials with relatively low impact per tonne, like aggregates and timber, where transport can have as much impact as the material itself. For more processed materials, transport impacts are less significant, especially when more efficient shipping is used for trans-continental transport.
- Considering site wastage is also relevant, particularly when comparing prefabricated materials which should have little waste on site, and other solutions which might have wastage rates of 10% or more.
- Taking into account disposal at end of life is a key decision for biomass, as is considering carbon locked up into products such as timber (known as sequestered carbon) which is associated with this choice. At present in the UK, producing energy from waste is not yet a common disposal option, as it is elsewhere in Europe, although it is increasing. As a result this is not so relevant, but the behaviour of biomass such as timber in landfill is an aspect which is still relatively unresearched, with some studies suggesting most timber will stay intact, whilst others estimate a significant proportion will decay to produce methane, with varying degrees of collection for energy recovery.
- For metals, recycling at end of life obviously provides a benefit, as does using recycled metals in the first place. Different approaches to estimating this benefit are in place across Europe, with the French considering only the impacts associated with manufacture of the metal as used, whilst the metals industry favour a substitution approach, with the net increase in recycled material arising at end of life substituting for primary production. BRE has used an approach midway between the two, giving credit for recycling based on the relative value of scrap to primary metal.

Using consistent data is important to ensure that the results are meaningful, and can be used over time for benchmarking or identifying successful strategies for reducing embodied carbon. Comparing data with different units, for example, measures that are just CO₂ or include all greenhouse gases will cause differences of between 5 and 10% at a building level. Similar differences might be seen for models that include or exclude transport, or site wastage. Much greater differences might be seen, particularly where timber or metals are significantly used, in models which consider sequestration, end of life and recycling in different ways. The level of detail for the study is also relevant. Some studies are based on a full bill of quantities and will include foundations, external works, staircases, boilers, doors, skirting board and gutters for example, while others might focus on only the main elements – walls, roof, floors and windows – potentially capturing less than half the total embodied carbon for a typical house³⁰. As building elements are interdependent – for example, naturally ventilated solutions may require exposed high mass floor slabs but no materials for ducts and fans; day-lit solutions may require greater floor to ceiling height and narrow floor plans hence more building envelope; lightweight solutions will affect the foundation design as well as thermal performance – it is important that all relevant aspects of the building are assessed when considering an alternative design option.

Recommended approach

At present, data and tools are not yet widely available using a consistent methodology to endorse a particular approach, although there are existing datasets, tools and approaches which are still useful in starting to measure embodied carbon. It is therefore more useful to ensure that any evaluation that is undertaken is carefully documented to ensure it is clear what data source has been used, and what scope has been considered. This will enable use of those models with the same data and scope to be benchmarked and compared.

The analysis of small numbers of projects using consistent data and approaches should allow the provision of initial benchmarks for those approaches, and potentially guidance on factors to adapt between different approaches.

It is also important that embodied carbon is considered alongside operational carbon. Changes to the building fabric can have significant impact on operational energy use, just as changes to the operational strategy can

³⁰ Anderson J, *Housing and Global Warming: the impact of housing construction and domestic space heating on the emission of greenhouse gases*, MSc Thesis, University of East London, 1998.

impact on building fabric. As the two metrics are both measured using CO₂, with the same resulting impact, and can be inter-dependent, it would be sensible in the longer term to link them and provide a benchmark for a combined operational and embodied carbon figure per year.

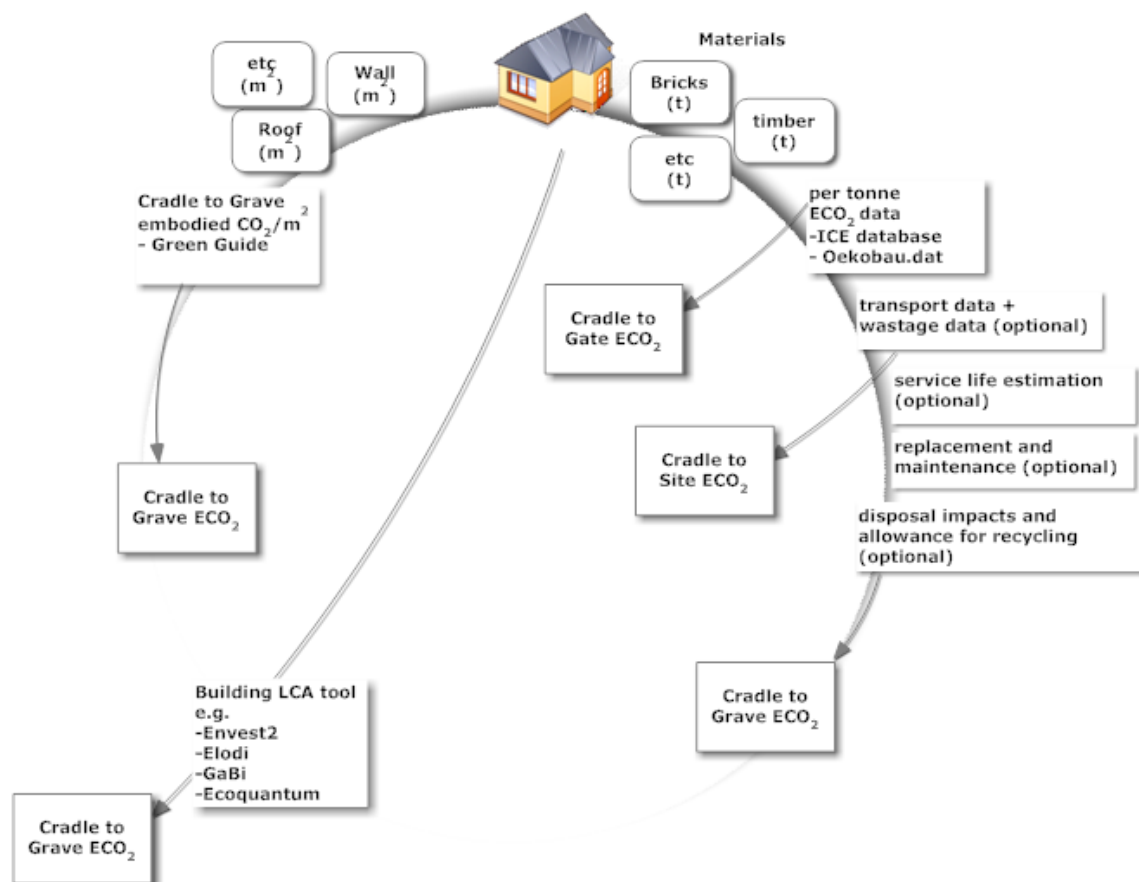


Figure 8: Process for calculating embodied carbon for a house

Data sources for embodied carbon

Embodied carbon can be provided as a single indicator, or as one of a number of environmental indicators (e.g. also covering resource use or toxicity), and measured using life cycle assessment (LCA). Within the UK, the construction products sector has worked with BRE over the past 15 years to develop a database of LCA data, including embodied carbon, for a broad range of construction materials consumed in the UK. This database includes information on all stages of the life cycle, including disposal. From 2011, the embodied carbon data will also be provided free online at www.bre.co.uk/greenguide, and will cover nearly 2000 specifications. This will enable calculation of the embodied carbon of a building by linking the areas of key element constructions (floors, walls, roof, windows) with the embodied carbon per m². Detailed design analysis would not be possible using this method, and inclusion of elements such as columns, structural cores and building services would need to be covered in a different way, but it offers a simple consistent approach to obtaining embodied carbon data for a building.

Cradle to Gate embodied carbon data are also available free of charge from the Inventory of Carbon and Energy (ICE) Database³¹ provided by Bath University. The ICE embodied carbon data are based on their review of freely available embodied carbon data and provide their best estimate of embodied carbon (Cradle to Gate) for most

³¹ <http://www.bath.ac.uk/mech-eng/serf/embodied/>

UK-consumed construction materials. ICE is intending to include other greenhouse gases and add data for end-of-life disposal of materials to the database at some point in the future.

A carbon footprint for a construction product is analogous to the embodied carbon, though for other products like cars, operation may be included within the footprint. BSI, DEFRA and the Carbon Trust have developed PAS 2050³² within the UK as a standard method to calculate the carbon footprint of products and services, but this is aimed at consumer products and the assessment method is not really geared towards such long-life products as construction products incorporated in buildings. Nevertheless, you may find some manufacturers reporting embodied carbon data to this standard.

Life Cycle Assessment or Analysis (LCA) is a technique to assess the environmental impacts associated with a product or service over its full life cycle and is another source of embodied carbon data. ISO standards ISO 14040:2006³³ and ISO 14044:2006³⁴ have been developed to broadly define LCA studies. The construction industry has also developed ISO 21930:2007³⁵ to define how construction products should be considered in terms of producing an Environmental Product Declaration (EPD) using LCA, to consistently determine the environmental impacts associated with a construction product to a common format to enable building-level assessment and comparison. Greenhouse gas emissions are one of the standard indicators normally assessed using LCA and within EPDs, so LCA studies and more specifically construction product EPDs can be used to provide embodied carbon data.

At present, various national schemes have been developed which are compliant with ISO 21930, for example as already mentioned, BRE's Environmental Profiles³⁶ and the Green Guide³⁷ within the UK, FDES and Inies³⁸ in France, IBU³⁹ in Germany and MRPI⁴⁰ in the Netherlands. Because these schemes have different approaches to measurement and assessment, though still within the ISO guidelines, industry and the European Commission have initiated a process to develop harmonised standards within Europe, for building level assessment of construction products, known as CEN TC350⁴¹. Once the CEN TC350 standards are in place, manufacturers should only need to undertake one LCA study to obtain the relevant data for their product manufacture. Due to differences in transport, construction practice, maintenance, exposure and disposal methods in different countries however, it is likely that different EPDs will have to be produced for products in different European regions to account for the resulting differences in environmental impact over the building life.

The German and Dutch EPDs are based on data provided by the manufacturer, with a 3rd party independent verifier checking that the EPD is an accurate representation of the underlying data. In France, only about 30% of FDES EPDs are verified, whilst in the UK, the BRE Environmental Profiles Certification scheme certifies that both the data provided by the manufacturer, and the EPD based on it, are accurate.

CEN TC350 will define a harmonised method for building level assessment of construction products, but evaluation of the results will be outside the standards – countries or organisations will be able to choose which indicators and any weighting to use, as well as making choices about how the building life cycle will be considered – for example over how many years the maintenance and refurbishment should be considered.

In addition to the embodied carbon data available freely for products via the EPD schemes, free national databases of generic construction product Life Cycle Inventory (LCI) data are also available such as the German Okobaudat⁴². The European Life Cycle Database (ELCD) Core Database Version II⁴³ is another free database providing LCI data which covers some construction materials – at present these data can be to a variety of

³² <http://www.bsigroup.com/Standards-and-Publications/How-we-can-help-you/Professional-Standards-Service/PAS-2050>

³³ *ISO 14040:2006 Environmental management -- Life cycle assessment -- Principles and framework*

³⁴ *ISO 14044:2006 Environmental management -- Life cycle assessment -- Requirements and guidelines*

³⁵ *ISO 21930:2007 Sustainability in building construction -- Environmental declaration of building products*

³⁶ www.bre.co.uk/envprofiles

³⁷ www.bre.co.uk/greenguide

³⁸ <http://www.inies.fr/IniesConsultation.aspx>

³⁹ <http://bau-umwelt.de/hp481/Environmental-Product-Declarations-EPD.htm>

⁴⁰ <http://www.mrpi.nl/Home/tabid/36/language/nl-NL/Default.aspx>

⁴¹ www.cen.eu/CEN/sectors/sectors/construction/sustainableconstruction/Pages/cen_tc350.aspx

⁴² <http://www.nachhaltigesbauen.de/baustoff-und-gebaeuedaten/oekobaudat.html>

⁴³ <http://lca.jrc.ec.europa.eu/lcaifohub/datasetArea.vm>

methodologies, although over time data will need to be verified to the International Life Cycle Database Handbook methodology⁴⁴, which is a different methodology to that of PAS 2050 and likely to be different from CEN TC350. Life Cycle Inventory data are a list of all the resources and emissions associated with a product or service. To convert these data to provide embodied carbon, all greenhouse gas emissions must be identified and considered along with their Global Warming Potential – a process most easily undertaken within an LCA tool which is the intended use for the ELCD.

Finally, there are two databases of construction LCI data which can be purchased. These are the ecoinvent⁴⁵ database developed by the Swiss Government, which also provides data for a wide range of chemicals and other materials, and the GaBi construction database⁴⁶. ecoinvent can be purchased as a standalone database, or to be used within an LCA software tool; GaBi must be used within the GaBi LCA tool.

A worked example for evaluating embodied carbon

The following is a straightforward approach to calculating the embodied carbon of a building before detailed information on the design is available.

Data on embodied carbon for construction materials can be obtained from a number of sources, but the BRE's Green Guide to Specification is one of the few free sources of consistent, UK-specific, cradle to grave CO₂e data for construction materials, provided per m² of construction. It can therefore be used at an early design stage when only the areas of construction elements are known.

Embodied carbon data have been provided by BRE since the publication of the Green Guide 4th Edition in early 2009. The Green Guide Online (www.bre.co.uk/greenguide) will provide this information free of charge from 2011. Certified data for specific manufacturers' products can be found at www.greenbooklive.com.

To calculate the embodied impact of a building in this way, the areas of each element need to be calculated and entered into a table or spreadsheet as below. Using the Green Guide, the embodied carbon for the proposed element specifications should then be noted for each element specification used, and entered together with the Element Number for later reference. Embodied carbon is then calculated using the area of the specification and the CO₂e factor for the specification.

Element	Area (m ²)	Green Guide Element Number/ Greenbooklive Appendix No.	Embodied carbon factor (kg/m ²)	Embodied carbon (kg)
Domestic ground floors		n/a		
Upper floors	1200	807280010: Post-tensioned slabs with screed	120	1200*120 = 144,000
Roof	400	812540033: Precast prestressed hollow slab, screed, EPDM	150	400 * 150 = 60,000
External walls	870	805300416: steel composite cladding, lightweight blockwork	150	870 * 150 = 130,500
Windows and curtain walling	380	831500013: treated softwood, TWAS, water based stain	88	380 * 88 = 33,440
Internal walls	150	809760002: steel stud and plasterboard	35	150 * 35 = 5,250
Floor finishes	1600	ENP405d: Proprietary nylon carpet with PVC backing	130	1600 * 130 = 208,000
Landscaping	n/a			
TOTAL GG elements				581,190

⁴⁴ <http://ict.jrc.ec.europa.eu/publications>

⁴⁵ <http://www.ecoinvent.org>

⁴⁶ <http://documentation.gabi-software.com/XIVConstructionMaterials.html>

The Green Guide does not provide information on the impact of foundations, non-domestic ground floors and building structure such as columns or core not included in the above elements, and BRE has not yet released per tonne embodied carbon data into the public domain. The embodied carbon associated with these elements can be calculated using data from Bath University's ICE database and the mass of materials used for these elements. As most of these elements can be considered to last for the life of the building, then no allowance needs to be made for any replacement or refurbishment during the building lifetime. There will be some inconsistency as the ICE database does not provide information on the impacts associated with transport or disposal of materials at the end of life, and the methodology with regard to the carbon sequestration and the treatment of recycling will be different to that used by BRE. However, in the absence of data from BRE this is a sensible approach to modelling embodied carbon for these building elements.

Building element	Material	Mass (kg)	Embodied CO ₂ per tonne (kg CO ₂ /kg)	Embodied CO ₂ (kg)
Foundations	Concrete (RC30)	400,000	0.153	61,200
Ground floor	Reinforced concrete (RC30, 100kg rebar/m ³)	240,000	0.241	57,840
Building structure (excluding perimeter columns)	Reinforced concrete (RC30, 50% GGBS, 100kg rebar/m ³)	3,000	0.180	480
TOTAL ICE elements				119,520

Total embodied carbon for the building = 581,190 + 119,520 kg = 700.7 tonnes

Embodied carbon per m² floor area = 700.7/1600 = 440 kg/m²

To reduce the embodied carbon of the building, two approaches can be taken: firstly to alter the building form, and secondly to modify the materials; or the approaches can be combined.

Focussing on those building elements with greatest impact may be the simplest way to start the process.

In this example, the majority of the embodied carbon is located in the floors and floor finishes. If the useable floor area is a project requirement, then the useable area of floor cannot be reduced but potentially the gross floor area and the impact of other elements can be reduced by altering the building form – for example by reducing from 4 to 3 floors and reducing the required circulation space, we can reduce the gross area of upper floors and external fabric with only a slight increase in area of ground floor and upper floor. The net result is shown overleaf.

GREEN GUIDE	ORIGINAL DESIGN				AMENDED DESIGN				SAVINGS	
Element	Area (m ²)	Green Guide Element Number/ Greenbooklive Appendix No.	Embodied carbon (kg/m ²)	Embodied carbon (kg)	Area (m ²)	Green Guide Element Number/ Greenbooklive Appendix No.	Embodied carbon (kg/m ²)	Embodied carbon (kg)	Embodied carbon (kg)	
Domestic ground floors		n/a				n/a				
Upper floors	1200	807280010: Post-tensioned slabs with screed	120	144,000	1000	807280010: Post-tensioned slabs with screed	120	120,000	24,000	
Roof	400	812540033: Precast prestressed hollow slab, screed, EPDM	150	60,000	500	812540033: Precast prestressed hollow slab, screed, EPDM	150	75,000	15,000	
External walls	870	805300416: steel composite cladding, lightweight blockwork	150	130,500	770	805300416: steel composite cladding, lightweight blockwork	150	115,500	15,000	
Windows and curtain walling	380	831500013: treated softwood, TWAS, water based stain	88	33,440	330	831500013: treated softwood, TWAS, water based stain	88	29,040	4400	
Internal walls	150	809760002: steel stud and plasterboard	35	5,250	150	809760002: steel stud and plasterboard	35	5,250	0	
Floor finishes	1600	ENP405d: Proprietary nylon carpet with PVC backing	130	208,000	1500	ENP405d: Proprietary nylon carpet with PVC backing	130	195,000	13,000	
Landscaping	n/a				n/a					
TOTAL GG elements				581,190					539,790	41,400
ICE	ORIGINAL DESIGN				AMENDED DESIGN				SAVINGS	
Element	Material	Mass (kg)	Embodied CO ₂ per tonne (kg CO ₂ /kg)	Embodied carbon (kg)	Material	Mass (kg)	Embodied CO ₂ per tonne (kg CO ₂ /kg)	Embodied carbon (kg)	Embodied carbon (kg)	
Foundations	Concrete (RC30)	400,000	0.153	61,200	Concrete (RC30)	400,000	0.153	61,200	0	
Ground floor	Reinforced concrete (RC30, 100kg)	240,000	0.241	57,840	Reinforced concrete (RC30, 100kg rebar/m ³)	300,000	0.241	72,300	14,460	

	rebar/m ³)								
Building structure	Reinforced concrete (RC30, 100kg rebar/m ³)	3,000	0.180	480	Reinforced concrete (RC30, 100kg rebar/m ³)	3,000	0.241	723	243
TOTAL ICE elements				119,520				134,223	14,703
TOTAL BUILDING				700,710				674,013	26,697

However, the impact of the amended building could be further reduced by altering the following elements (as an example):

- the ground floor concrete impact can be reduced by using cement replacements (50% GGBS replacement = 0.061 kg CO₂ reduction per kg concrete);
- the upper floor impact can be reduced by using power floating rather than screed (807280055 – 93 kg/m²); and
- the impact of floor coverings can be reduced by changing to an alternative specification (ENP405f – 120 kg/m²).

The effect of these changes, reducing the total embodied carbon, is shown in the graph below and the table overleaf.

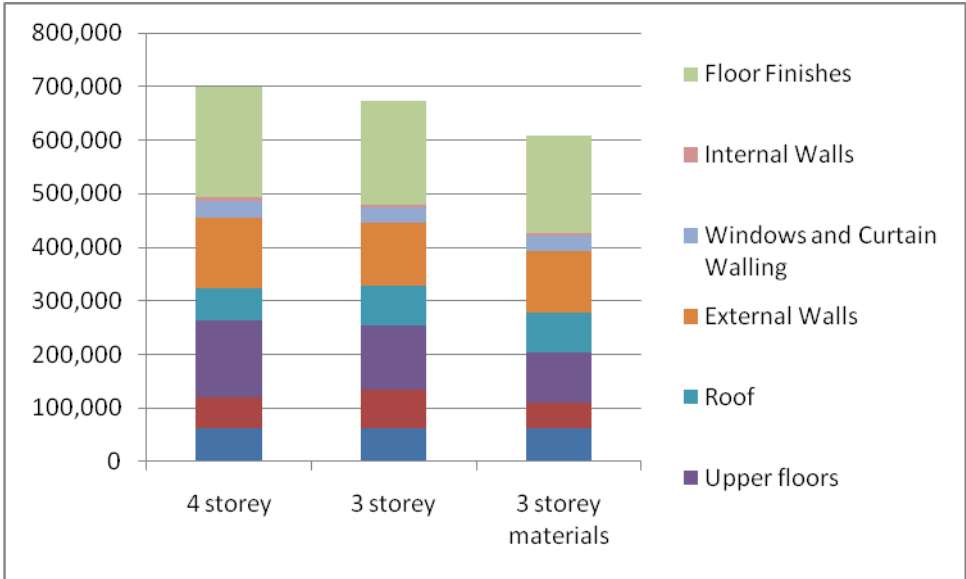
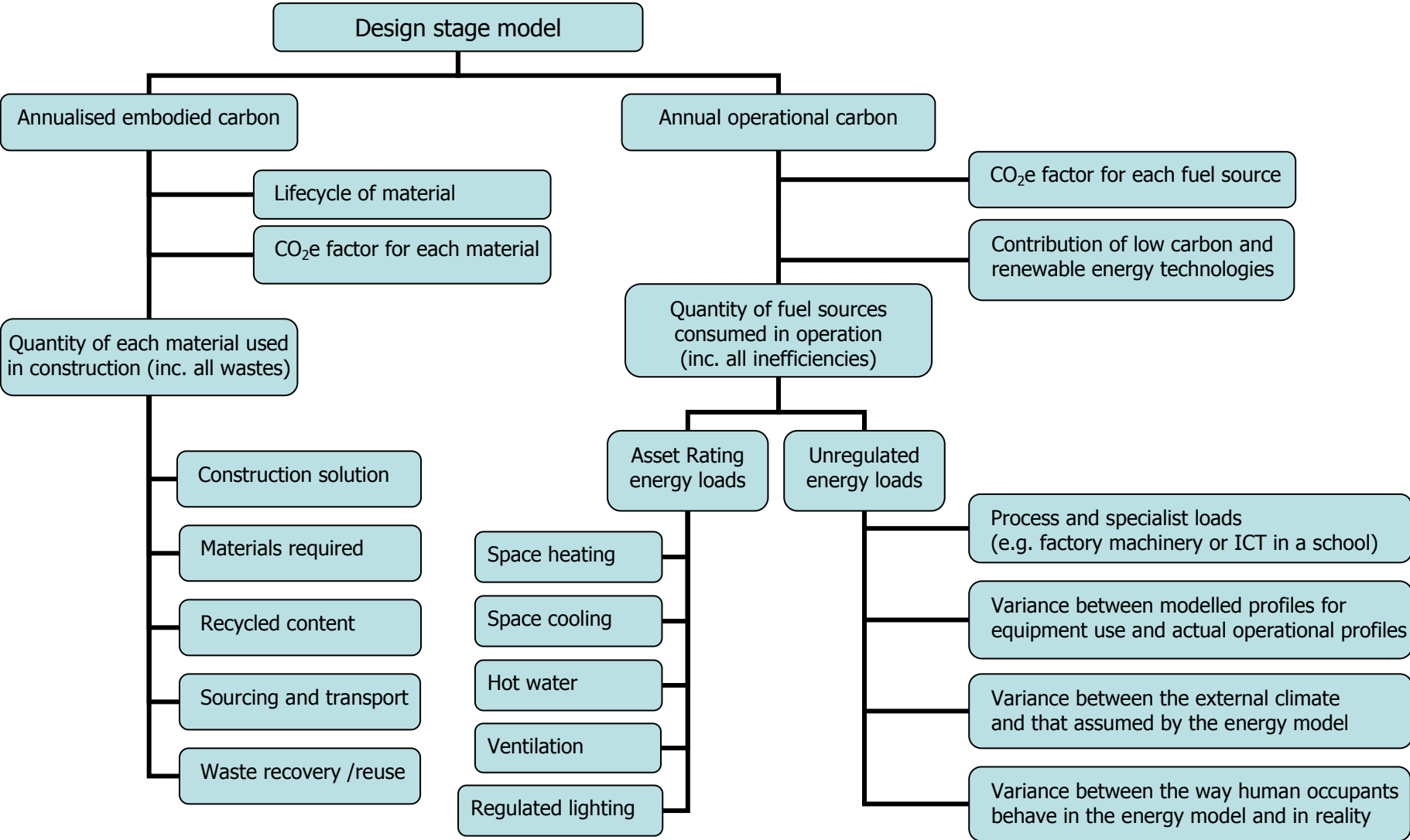


Figure 9: Chart showing the reduction in embodied CO₂ from changing the building form and altering the materials specification

GREEN GUIDE	ORIGINAL DESIGN				AMENDED DESIGN				SAVINGS	
Element	Area (m ²)	Green Guide Element Number/ Greenbooklive Appendix No.	Embodied carbon (kg/m ²)	Embodied carbon (kg)	Area (m ²)	Green Guide Element Number/ Greenbooklive Appendix No.	Embodied carbon (kg/m ²)	Embodied carbon (kg)	Embodied carbon (kg)	
Domestic ground floors		n/a				n/a				
Upper floors	1000	807280010: Post-tensioned slabs with screed	120	120,000	1000	807280055: Powerfloated post-tensioned slabs	93	93,000	27,000	
Roof	500	812540033: Precast prestressed hollow slab, screed, EPDM	150	75,000	500	812540033: Precast prestressed hollow slab, screed, EPDM	150	75,000	0	
External walls	770	805300416: steel composite cladding, lightweight blockwork	150	115,500	770	805300416: steel composite cladding, lightweight blockwork	150	115,500	0	
Windows and curtain walling	330	831500013: treated softwood, TWAS, water based stain	88	29,040	330	831500013: treated softwood, TWAS, water based stain	88	29,040	0	
Internal walls	150	809760002: steel stud and plasterboard	35	5,250	150	809760002: steel stud and plasterboard	35	5,250	0	
Floor finishes	1500	ENP405d: Proprietary nylon carpet with PVC backing	130	195,000	1500	ENP405f: Proprietary nylon carpet with PVC backing	120	180,000	15,000	
Landscaping	n/a				n/a					
TOTAL GG elements				539,790					497,790	42,000
ICE	ORIGINAL DESIGN				AMENDED DESIGN				SAVINGS	
Element	Material	Mass (kg)	Embodied CO ₂ per tonne (kg CO ₂ /kg)	Embodied carbon (kg)	Material	Mass (kg)	Embodied CO ₂ per tonne (kg CO ₂ /kg)	Embodied carbon (kg)	Embodied carbon (kg)	
Foundations	Concrete (RC30)	400,000	0.153	61,200	Concrete (RC30)	400,000	0.153	61,200	0	
Ground floor	Reinforced concrete (RC30, 100kg rebar/m ³)	300,000	0.241	72,300	Reinforced concrete (RC30, 50% GGBS, 100kg rebar/m ³)	300,000	0.180	48,000	24,300	

Building structure	Reinforced concrete (RC30, 100kg rebar/m ³)	3,000	0.241	723	Reinforced concrete (RC30, 50% GGBS, 100kg rebar/m ³)	3,000	0.180	480	243
TOTAL ICE elements				134,223				109,680	24,543
TOTAL BUILDING				674,013				607,470	66,543

Appendix 3: Elements in embodied and operational carbon



Box 3: Case study: Combined assessment of operational and embodied carbon in Germany

The German Green Building Council's sustainable building evaluation scheme, DGNB, launched in 2009. Like BREEAM and the Code for Sustainable Homes, DGNB uses a number of credits in the environmental, social and economic sphere to evaluate the performance of buildings. It assesses operational and embodied carbon to provide an overall figure for combined carbon, annualised over a defined period.

Limit, reference (or standard practice) and target values are provided, and credits can only be awarded if the building achieves better than the limit value. If the building scores better than the reference value 50% of credit is awarded, and 100% of the credit is available if the buildings scores better than the target value.

Operational performance is assessed using the Energy Performance in Buildings Directive compliant method developed in Germany, EnEV. A federal database is freely available giving environmental data for common construction materials, including information on embodied CO₂ equivalent. This, in combination with the standardised component life data, can be used to assess the embodied impact of buildings over a given study period. Energy data for the separate operational assessment can then be linked with impact data, such as carbon emissions for different fuels, to provide total carbon impact data for the building over the study period.

Further information: www.nachhaltigesbauen.de/baustoff-und-gebaeuedaten.html

Appendix 4: Sources of further information

Sources of information and advice on good practice include:

Organisations

Advisory bodies

- **The Carbon Trust** provides specialist support and advisory services to business and the public sector to help cut carbon emissions, save energy and commercialise low carbon technologies – particularly relevant to non-domestic buildings, including guidance on low carbon refurbishment of buildings. www.carbontrust.co.uk
- **The Energy Saving Trust** is a non-profit organisation that provides free and impartial advice to help people to save energy and reduce carbon emissions – particularly relevant to domestic buildings. www.energysavingtrust.org.uk
- **WRAP** works in England, Scotland, Wales and Northern Ireland to help businesses and individuals reap the benefits of reducing waste, develop sustainable products and use resources in an efficient way. www.wrap.org.uk, www.zerowastescotland.org.uk. The WRAP information sheet: '*Cutting embodied carbon in construction projects*' will help you identify basic cost-effective actions to reduce the carbon impact of the materials used in your construction projects.

Industry bodies

- **Low-Carbon Construction Innovation and Growth Team (2010)**. The LCC-IGT was a Government-initiated and industry-led project which sought to ensure the UK construction industry is 'fit for purpose' for delivering a low carbon future. Its recommendations are available at: www.bis.gov.uk/constructionigt.
- **The Strategic Forum for Construction** is the umbrella body for the UK construction industry, and provides an interface between government and the construction sector. Their Carbon sub-group works to address the target for reducing carbon emissions in the construction and manufacturing processes by 15%, as set out in the Construction Commitments and Strategy for Sustainable Construction. www.strategicforum.org.uk
- **Chartered Institution of Building Services Engineers (CIBSE)** is an industry body providing a range of energy services, best practice information and training. Publications of note include the TM22 Energy Assessment and Reporting Methodology for assessing the energy performance of an occupied building based on metered energy use. www.cibse.org.
- **Zero Carbon Hub** is a public/private partnership established to take day-to-day operational responsibility for co-ordinating delivery of low and zero carbon new homes by 2016. www.zerocarbonhub.org
- **Zero Carbon Task Force for schools**. This Government initiative published its final report in Jan 2010.

Sources of information

Regulatory and legislative requirements

- **EU Energy Performance of Building's Directive (EPBD)** requires all buildings to be 'nearly zero carbon' by 2020, which has driven the UK's goals of zero carbon homes by 2016 and zero carbon non-domestic buildings by 2019. http://ec.europa.eu/legislation_summaries/energy/energy_efficiency/l27042_en.htm
- **EU Renewable Energy Directive** requires EU countries to commit to specific targets for renewable energy. <http://ec.europa.eu/energy/renewables>
- **EU Emissions Trading Scheme (ETS)** is a trading scheme applicable to the UK's main energy-intensive industries. The ETS aims to provide clear incentives for additional investment in energy efficiency and cleaner technology. <http://ec.europa.eu/environment/climat/emission>

- **Climate Change Act** sets a legally binding long-term framework for the UK to cut carbon emissions. www.decc.gov.uk/en/content/cms/legislation/cc_act_08/cc_act_08.aspx
- **Climate Change Levy** subjects industrial energy users to a tax on energy use. Introduced in 2001, the CCL incentivises industry to improve energy efficiency and move to low carbon energy. www.decc.gov.uk/en/content/cms/what_we_do/change_energy/tackling_clima/ccas/cc_levy/cc_levy.aspx
- **Building Regulations** for the conservation of fuel and power set out the technical requirements for a building to meet a minimum standard of performance suitable for planning application. www.planningportal.gov.uk/england/professionals/buildingregs/technicalguidance/bcconsfppart/
- **Energy Performance Certificate (EPC)** at the point of construction or resale is a system to indicate how a building's specified energy and carbon performance compares to a benchmarking standard for a compliant building of similar form and function. <http://epc.direct.gov.uk>
- **Display Energy Certificate (DEC)** for operational buildings provides a more accurate measure of the energy consumption and associated carbon emissions from a building in use. www.communities.gov.uk/publications/planningandbuilding/displayenergycertificates
- **Consequential improvements** – this sub-requirement of the Building Regulations is defined in Part L and requires efficiency improvements to be made to an existing building when significant building works take place on it. www.planningportal.gov.uk/england/professionals/buildingregs/technicalguidance/bcconsfppart/
- **Onsite renewable energy policies (e.g. The Merton Rule)** – the London Borough of Merton set a precedent for the introduction of a planning requirement for buildings to feature onsite renewable energy and low carbon technologies.

Schemes and initiatives

- **CRC Energy Efficiency Scheme (CRC-EES)** is a mandatory energy efficiency scheme aimed at improving energy efficiency and cutting emissions in large public and private sector organisations. www.environment-agency.gov.uk/business/topics/pollution/98263.aspx
- **BSI Kitemark Scheme.** The BSI has launched a Kitemark scheme for Energy Reduction Verification in recognition of those organisations creating an effective Environmental Management System. This Kitemark can be used to gain a CRC-EES Early Action Metric. www.bsigroup.com/en/ProductServices/energykitemark/Kitemark-for-energy/
- **Soft Landings** is a process in which designers and constructors get involved with building occupants before and beyond practical completion to ensure occupants make the best use of their building following handover, so as to reduce the gap between design intent and performance in use. Soft Landings promotes retaining the design team and maintaining their involvement in a project until the building's required performance levels have been established in operation. The carbon aspects of a building's performance are one element of the wider Soft Landings approach. www.bsria.co.uk/services/design/soft-landings.
- **Programme for Carbon Reduction (P4CR)** is an initiative and toolkit to help NHS procurement professionals reduce carbon emissions when buying goods and services. www.sdu.nhs.uk/publications-resources/23/Procuring-for-Carbon-Reduction-P4CR--NEW/
- **RE:FIT** is a programme operated by the London Development Agency to help public bodies use pre-selected energy service companies (ESCo) to retro-fit energy efficiency measures in buildings. The ESCo guarantees a set level of energy and cost savings over an agreed payback period, thus providing a net saving longer term. www.lda.gov.uk/projects/refit/index.aspx

Standards

- **CEN TC350** is series of voluntary standards for assessing the sustainability of construction products at building level which are currently being developed by the European Commission. www.cen.eu/cen/Sectors/Sectors/Construction/SustainableConstruction/Pages/CEN_TC350.aspx
- **PAS 2050** is a Publicly Available Specification (PAS) for a method for measuring the embodied greenhouse gas emissions from goods and services. www.bsigroup.com/Standards-and-Publications/How-we-can-help-you/Professional-Standards-Service/PAS-2050

- **BS EN 16001** is a British Standard which specifies the requirements for an Energy Management System. www.bsigroup.co.uk/en/Assessment-and-Certification-services/Management-systems/Standards-and-Schemes/EN-16001-Energy-Management-Systems/

Tools and data sources for embodied carbon (for public access)

- **The Environment Agency** has developed a free calculator for estimating the carbon footprint from construction materials and activities on site. www.environment-agency.gov.uk/business/sectors/37543.aspx
- **The University of Bath** has developed a database to determine the embodied energy and carbon of a large number of building materials. The database has been used to release an Inventory of Carbon & Energy (ICE). www.bath.ac.uk/mech-eng/sert/embodied/
- **BRE's Green Guide to Specification.** The UK construction products sector has worked with BRE over the past 15 years to develop a LCA database for nearly 2,000 of the most significant and common products used in constructing buildings. This database includes information on all stages of the life cycle, including disposal, and has been developed to a consistent methodology (BRE Environmental Profiles Methodology) based on data provided by industry. The data are being made available at www.bre.co.uk/greenguide.
- **The European Life Cycle Database** (EU Joint Research Centre). The ELCD comprises Life Cycle Inventory (LCI) data from front-running EU-level business associations and other sources for key materials, energy carriers, transport, and waste management. <http://lca.jrc.ec.europa.eu/lcainfohub/datasetArea.vm>.

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