Specifying and designing public sector low carbon buildings
- the productivity design approach

Delivering the future, today

Project owner’s guide
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1. Introduction

This guide is designed to assist project owners to deliver sustainable low carbon buildings. It details a five-step process that if followed will markedly improve the quality of the internal environment of the building, assist in assuring that it achieves best value and result in significant carbon savings.

It is designed to be read in conjunction with the other guides within the Carbon Trust Delivering the future, today pack. The Delivering the future, today pack contains the following documents and tools:

**Documents**

Executive summary
A summary of the suite of documents and tools.

Setting the scene
This document demonstrates the benefits that can be achieved and the problems that can be avoided by following a robust process in the procurement of low carbon new build and refurbished buildings.

The project owner’s guide
This brief guide is designed to be read by the senior project owner. It introduces the requirement to change the way we procure new build and refurbished buildings and summarises the Carbon Trust five-step process to achieving that aim.

**The project manager’s guide**
This more detailed guide should be read by project managers and members of the design team. It lays out a detailed process that if followed should ensure that a sustainable low carbon building, be it a new build or refurbishment, representing Best Value with minimum whole-life costs should be delivered.

**Tools**

Client value preparation tool
Skills, knowledge and experience tool
Low carbon tracker.

**Authors**

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Renate Powell, CEng BEng, has been an energy efficiency consultant for almost 20 years, and has worked with the Carbon Trust in Scotland for seven years. During the past four years Renate has developed the support offered by the Carbon Trust, for new builds and refurbishments, assisting with the process from specification, through design, to operation. For Renate, energy efficiency is a passion in both her personal and professional life.
2. Setting the scene summary

The setting the scene document provides a detailed analysis of the challenges facing organisations when procuring new buildings or refurbishments. This page provides a brief summary of the document.

One of the main issues facing the majority of recent projects reviewed was that the productive workplace had been compromised in one or more of four areas:

- **Temperature**: overheating; trapped hot air at ceiling height; building too cold on a Monday morning; cold draughts next to windows; solar gains through windows
- **Daylight**: too little daylight; glare causing blinds to be lowered; lack of integration with lights
- **Ventilation**: stuffy rooms; draughts from ventilation; ventilation always on full fresh air even at low occupancy
- **Acoustics**: noise from open windows; poor control of noise causing retrofit of acoustic treatment.

These factors also impact on the energy usage of the building. For example; overheating will probably be solved by the retrofitting of air conditioning; glare causing blinds to be lowered will result in greater use of artificial lighting.

Building Standards set minimum standards that require to be complied with, but allow the building owner to specify higher standards and cover other subjects that will enable lower carbon emissions to be designed.

Introducing operational targets (in addition to the Building Standards’ design targets) at the outset to define how the building will perform in use, can transform a project. These challenge designers to make the building shape and glazing work to minimise the services demands as the first design step. Subsequently the building services need to be efficient and be controlled to supplement for the users’ needs.

The operational targets are tested in a more rigorous commissioning process and any deviations from the targets rectified to ensure the resulting building meets its design intent.

To manage this process it is essential that all individuals involved in a project have access to the skills, knowledge and tools that they need. This includes understanding and use of a whole-life costing procedure with realistic assumptions on future energy and carbon prices.

Angus Council’s Seaview Primary School won the Carbon Trust Scotland Low Carbon Building Award for a new building in 2010.

They used an in-house team to manage the development process consisting of architects, interior designers, mechanical and electrical engineers, quantity surveyors as well as staff from the Council’s energy and maintenance teams. Natural ventilation by automated high level windows is controlled by the BMS based on inside and outside temperatures and internal CO₂ levels.

Where mechanical ventilation is required, heat recovery is used to temper the incoming air. The school optimises its use of daylight using clerestory windows and skylights, combined with lighting controls based on occupancy detection and dimming when there is enough daylight.

Seaview Primary School had no overall cost premium over a comparable building with higher usage. The energy consumption is 49.8% lower than a typical new build primary school resulting in an annual cost saving of 67.7%. The lower energy consumption at the school will provide cost savings year-on-year through the life of the building.

The following chapter summarises the step-by-step process that should be followed to ensure that the resulting new build or refurbishment provides an exemplar result.

The following figure outlines each of the five steps and summarises the processes required for that step.

The process will vary slightly depending on the chosen procurement route. With an in-house design team, the bidding team selection in the preparation step will not be required but the selection of the in-house team during organisation preparation will need to be more rigorous.

At the beginning of each step there is a table showing the main processes involved, who would normally be responsible for them and what their deliverables are. The green dot represents the main responsible person and the orange circle represents the individuals supporting the processes.

Again this will vary slightly depending on the procurement route taken. The project manager role may differ depending on whether they are a member of the client organisation, part of the design team or an independent resource.

The tools described in this guide are available on the Carbon Trust website at www.carbontrust.co.uk/scotland and may be downloaded for use on any project. The principles within this guide and in the tools apply to the private sector as well as the public sector so their use need not be restricted to public sector organisations.

Figure 1. Great Glen House, the headquarters of SNH in Inverness.
**Step 1. Preparation**

The first step allows an organisation to assess its readiness to produce a low carbon new build or refurbishment and to identify any gaps in knowledge or skills that need to be filled. It also brings the organisation to the stage when an outline business case can be produced, a site chosen and a design team or delivery partner chosen.

This step contains a number of the most important processes in the methodology. As was shown in the "Setting the scene" document many projects take the wrong path from the start either by having an internal or external team responsible for delivering the building with some key skill gaps, failing to set rigorous targets for the building to meet in operation or undervaluing the low carbon measures at the business case stage.

This step consists of a number of processes some of which need to run concurrently. These processes are shown in the following table along with the responsible person and the deliverables from the process:
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● main driver  ○ additional driver
A. Project owner appointment

The project owner or senior responsible officer (SRO) is normally defined as an individual with the “status and authority to provide the necessary leadership” (1).

If the intention of the project is to deliver a low carbon building this individual will need to be prepared to champion the low carbon aspects of the building. This will require a broad level of knowledge covering the requirements for a productive workplace, the synergies with a low carbon building, the design hierarchy required to minimise energy demand, the gap between traditional building procurement strategies and those required to deliver a low carbon building and the importance of using a robust whole-life costing methodology. Further information on these areas is provided in the ‘Setting the scene guide’ and the ‘Project manager’s guide’. Some training may need to be provided to the Project Owner to ensure that they have the skills required.

B. Setting the values and overarching targets

The responsibility for delivering a low carbon building rests with the client. It is up to the client, and therefore the project owner, to establish its low carbon objectives for the design team and to provide them with targets for the building performance. This process needs to be led by the project owner and progress should be reported back to them on a regular basis.

This is achieved by first determining appropriate client values to apply to the project, setting appropriate targets and performing a gap analysis to ensure that the organisation has the required skills and resources to deliver the project.

Setting the values is achieved by holding a charrette, which needs to be attended by senior management. An agenda and charrette report format are provided in the project manager’s guide. Prior to holding the charrette an assessment is made of the organisation’s readiness to deliver a low carbon building. An assessment tool has been developed to assist this process and the output of this should be discussed at the charrette.

At this stage, the initial design and operational targets are to be agreed. Recommended targets are provided in the project manager’s guide.

The next stage is for the organisation to commit to using whole-life costing and to agree on a methodology. The finance director will need to be involved in this process.

Finally the strategy for the outline business case should be determined.

Project owner checklist

- Value charrette held
- Organisation preparedness evaluated
- Overarching design and operational targets set
- Whole-life costing methodology agreed
- Business case strategy agreed.

Figure 2. Carnbooth House Hotel. Good wall and window insulation in this listed building has given exceptional comfort to guests.
C. Organisation preparation

Once the initial design aim has been determined, an in-house team is selected to deliver the project. The roles and responsibilities of the team members will be dependent on the procurement route used and the required balance between in-house expertise and external advisers. To fulfil the low carbon and sustainability objectives of the project specific expertise and skills will be required.

There are three main elements to this process. The first element is the assessment of the skills, knowledge and experience of the in-house team who will be preparing the business case and delivering the project. This is achieved by the means of the skills, knowledge and experience tool. Each individual involved in the project will rate themselves using the tool. The resulting analysis of the entire team is used to identify any knowledge gaps and determine how they can be filled i.e. by use of training or external advisers.

The next element is the appointment of a low carbon adviser. This is an individual with a good level of knowledge of carbon and sustainability issues. They may be an internal or external appointee but their main role is to monitor the low carbon and sustainability aspects of the project and to provide guidance to the project owner and the in-house team. They will use a low carbon tracker to track all relevant issues throughout the project. A proforma tracker is available on the Carbon Trust website.

Finally, at this stage initial engagement is required with the building users to determine their high-level requirements.

D. Site selection

In many cases, site selection takes place without detailed analysis of the potential impact of the site on the building performance.

Where a new build is the chosen option a full options appraisal should be carried out to ensure that the optimal site is chosen and the building is correctly positioned on the site. This may require the use of dynamic thermal simulation to determine the effects of shading, prevailing weather and their impact on building orientation.

Figure 3. Good daylight at Acharacle School entrance area.

Project owner checklist

- In-house team knowledge assessed
- Training needs identified
- Low carbon adviser appointed
- Low carbon tracker in place
- User requirement document produced.

Project owner checklist

- Whole-life costing evaluation of potential sites received.
E. Adviser and bidding team selection

When appointing an external adviser, design team or other external contracting partner, understanding their depth of knowledge of low carbon practicalities and sustainability issues is of paramount importance.

Where an external design or design and build team or external advisers are required a skills, knowledge and experience tool designed specifically for this process is available. It is used during a selection and tender process to assist in assessing the applicants and to identify areas for further investigation.

In the case of selecting an external design team the concept of meeting overarching and detailed design and operation in use targets may be new to the bidding teams. The contractual terms for their appointment will need to reflect the additional obligations that they will be subject to. Proposed additions to standard contract clauses are shown in the ‘Project manager’s guide’.

Project owner checklist

- External bidding team or external adviser skills, knowledge and experience evaluated
- Contract terms amended.

Figure 4. Carrochan - National Park Headquarters in Balloch - a breathing building.
Step 2. Design

The design step of the methodology assists in providing a holistic approach to the design of the new build or refurbished building. It ensures that there is opportunity for innovative design approaches, that the design team is given sufficient information about the required internal environment of the building, that a commissioning strategy is planned as part of the design process and that regular reviews ensure that the design will meet the values set out by the client.

This step is usually design team led with support and monitoring provided by the low carbon adviser and in-house team.

A high level of interaction with the users may be required to ensure that the detailed targets are appropriate for the intended use.
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- ○ main driver
- ○ additional driver

- A summary of the decisions made
- Environmental brief, schedules and room data sheets
- Strategy document and commissioning agent role specification
- Report on ability of design to meet objectives at key milestones
- Monitored in low carbon tracker
A. Design charrette
Once the detailed room requirements and user specifications such as output specifications and functional relationships have been set, the detailed design process can be commenced.

A design charrette involving the project owner, the in-house team, the design team and the user representative is to be held at the beginning of the design process. This gives an opportunity for all parties involved in the project to discuss the client values and design strategies for meeting them. After the charrette a report should be produced detailing decisions made. For the charrette to be a success attendance should be compulsory.

B. Establishing detailed targets
Detailed requirements will need to be established for the building as a whole and for each room in the building using performance-in-use targets. This is a time consuming process involving a combination of design team participants and representatives of the users. The user representatives will include final users of the building, those that will be operating and maintaining the building and service providers to the building such as IT.

Developing detailed targets is a lengthy process but essential to the delivery of a low carbon building. It consists of three elements. An environmental brief that summarises the targets applying to the whole building; environmental schedules specify the targets for each space within the building and room data sheets specify detailed requirements for each room. These are developed in conjunction with the building users.

The building designers must adhere to these targets or agree any deviations with the client.

C. Commissioning strategy
Commissioning is vital to the efficient operation of a building. It is normally specified on a system-by-system basis, which can lead to poor interfaces and conflicting operation - for example a heating system operating simultaneously with a local cooling system.

Setting a commissioning strategy early in the design process ensures that the necessary monitoring is available for the process. It requires the appointment of a commissioning adviser (or agent). This may be an in-house resource, a member of the design team or an external adviser. At this stage an appropriate monitoring and reporting structure once the building is in operation needs to be included.

Project owner checklist
- Design charrette held
- Charrette report received

Project owner checklist
- Environmental brief received
- Environmental schedules received
- Room data sheets received
D. Design evaluation

Once a contract is let or a traditional design is underway, there needs to be a number of key reviews to establish that the energy and sustainability objectives are being met.

At the preparation step, a number of targets will have been set. This will then have been followed by the setting of detailed targets prior to detailed design commencing. The design will require regular monitoring to ensure that it is still on track to meet the targets. This will be achieved by reviews of the project model and drawings and specification by the low carbon adviser which enables issues to be identified before they become entrenched in the design and become costly to correct.

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Project owner checklist

☐ Require low carbon adviser to report divergences from targets as they occur

☐ Request report on design status at key milestones.

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E. Financial, contractual and risk arrangements

During the design process, it is essential that the financial and contractual arrangements required to deliver the required building are considered.

One of the project owner’s main roles is liaison with the funders and other key stakeholders in the project. To perform this role regular updates will be required from the project manager on the project costs and risks. It is particularly important to be notified if any unusual technologies are to be used.

Another issue that may require addressing by the project owner is that the processes and targets described in this guide may not be familiar to all parties involved in the project. Ensuring that the contractual arrangements embed these principles may require additional drafting and reviews by the legal department to ensure that the targets are legally enforceable.

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Project owner checklist

☐ Monthly updates from project manager on financial and risk elements

☐ Review with target enforceability with legal department prior to contract finalisation.

Figure 6. The Potterrow Building, the University of Edinburgh. A place to attract high calibre students without the heavy energy penalty.
Step 3. Pre-construction

Step 1 and 2 of this guide should have ensured that an appropriately skilled team has developed a low carbon design with optimal environmental conditions. All of these benefits can be lost if they are not translated into robust contractual terms and delivered by a construction team with the necessary understanding and skills.

Evaluating the tenders and ensuring that key design features are not lost without the implications being understood is a key task of both the in-house team and the low carbon adviser.

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- ○ main driver
- ○ additional driver

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**Preparation**
- In-house team selection
- Setting the values and overarching targets
- Organisation preparation
- Site selection
- Bidding teams selection

**Design**
- Design charrette
- Establishing detailed targets
- Commissioning strategy
- Design evaluation
- Finance, contractual and risk arrangements

**Pre-construction**
- Bid evaluation
- Financial close

**Construction**
- Construction
- Commissioning

**Use**
- Monitoring and reporting
- Verifying of performance in operation
- Post occupancy evaluation
A. Bid evaluation
The key to good bid evaluation is to be explicit and detailed in what is to be returned with tenders.

Where a bid process is used to select a contractor, the low carbon adviser must take an active role in the Invitation To Tender (ITT) drafting and tender evaluation. They will be able to use the skills, knowledge and experience tool to evaluate the tenderers and to recommend questions for interviews. The contractors should be required to commit to actual targets and demonstrate what has actually been achieved in previous projects, not provide statements of good intentions and design targets. The targets should be embedded in the contracts.

Project owner checklist
- Low carbon adviser involved in Invitation To Tender and tender evaluation
- Tenderers agree to meet all required targets
- Targets reflected in legal agreements.

B. Financial close
Many low carbon and sustainable features are lost at financial close due to value engineering.

To avoid the loss of low carbon attributes of a building it must be ensured that the impacts of any value engineering is both technically modelled using dynamic thermal simulation and financially modelled using whole-life costing to ensure that they meet the Best Value test.

Project owner checklist
- Value engineering changes dynamically simulated
- Value engineering changes financially modelled using whole-life costing.

Figure 7. Dundee Council Headquarters. A combination of refurbishment and new build. The design team and client worked hard to meet the demanding requirements of conservation work within a listed building, while seeking to maintain the BREEAM excellent rating, and safeguard its low energy features.
Step 4. Construction

At the construction stage the emphasis is on close monitoring of the build and a robust commissioning procedure.

The low carbon adviser and the commissioning agent will perform the main roles at this stage, reporting regularly to the project owner on progress.

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- ☐ main driver
- ☐ additional driver
A. Construction contractual issues
A well-designed building relies on an effectively structured contract to be delivered.

Once construction starts, the in-house team, the low carbon adviser and the commissioning adviser will require access to the site to allow monitoring of the build quality. The low carbon adviser will be maintaining the carbon tracker during the construction period and it should be a contractual requirement that all items on the tracker must be completed.

If the contract allows for substitution of materials or equipment during construction there must be an obligation for the impact of that substitution to be dynamically simulated and its impacts on the whole-life costs to be evaluated.

Project owner checklist

☐ Right of access to site for in-house team, low carbon adviser and commissioning adviser embedded in contracts

☐ Requirements for material or equipment substitutions to be dynamically and financially modelled.

Figure 8. Solais House - NG Bailey building in Motherwell. Although the entrance had to be south facing glazing for planning reasons, the building owner included PhotoVoltaics (PV) in the glass that additionally shade the entrance from high solar gains.

B. Commissioning

As was discussed in the “Setting the scene” document a robust commissioning process will play an important role in identifying defects, ensuring controls are correctly set and that the building meets its design intent. The strategy for this should have been set at the design stage.

The commissioning strategy is likely to require the commissioning process to be started soon after construction commences. It will consist of an iterative approach initially commissioning individual items but then confirming that it operates correctly in conjunction with building fabric and services and that the controls operate correctly. Final checks will be made once the building is occupied.

Project owner checklist

☐ Regular reports on commissioning received from commissioning adviser.
Step 5. Use

The period between practical completion and the end of the defects period allows for detailed monitoring of the building to ensure that it meets its design intent and to identify and rectify any issues found.

The ongoing monitoring of a building once construction has been completed is often neglected. Ensuring that this does not occur requires responsibility to be allocated to an appropriate individual. This may be a member of the in-house team, the low carbon adviser or the commissioning agent.

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- **main driver**
- **additional driver**

**USE**: main driver, additional driver
A. Monitoring and reporting
A monitoring and reporting strategy was considered early in the design process to allow the necessary monitoring equipment to be installed.

The project owner should be given a monthly report on the building monitoring during the commissioning and defects period. The report needs to highlight any issue identified, who “owns” the problem, how much it is costing and the recommended action to rectify it.

Project owner checklist

☐ Monthly reports received.

B. Verifying performance in operation
As part of the preparation and design steps both overarching and detailed targets will have been given contractual weight. These will require verifying.

Periodic formal reviews of the targets should take place once the building has been fully commissioned for an appropriate period. For a complex building, this will be a two to three year period. These reviews will confirm that the design and operational targets have been met.

Project owner checklist

☒ Programme of periodic reviews of targets in place.

Project owner checklist

☒ Disseminate post occupancy evaluation results to senior management team.

C. Post occupancy evaluation
Post occupancy evaluation is a valuable tool to identify the success of the building in achieving its low carbon objectives without compromising the internal environment.

The post occupancy evaluation is likely to consist of a variety of processes including evaluating the monitoring data, conducting surveys, interviews and workshops with the building users and performing walkthroughs to identify issues. The results of the evaluation need to be disseminated to the organisation senior management team so that it can be used to influence other projects.

Figure 9. After five years in use, Great Glen House is still highly rated by its occupants.
The Carbon Trust is a not-for-profit company with the mission to accelerate the move to a low carbon economy. We provide specialist support to business and the public sector to help cut carbon emissions, save energy and commercialise low carbon technologies. By stimulating low carbon action we contribute to key UK goals of lower carbon emissions, the development of low carbon businesses, increased energy security and associated jobs.

We help to cut carbon emissions now by:

- providing specialist advice and finance to help organisations cut carbon
- setting standards for carbon reduction.

We reduce potential future carbon emissions by:

- opening markets for low carbon technologies
- leading industry collaborations to commercialise technologies
- investing in early-stage low carbon companies.

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