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Low Carbon Design Tools
Executive Summary

About this Document:

This document summarises *Low Carbon Design Tools*, developed by the RIBA as part of a suite of Climate Change Tools to encourage architects to engage with the issue of climate change and to deliver low-carbon new buildings and low-carbon refurbishment of existing buildings.

You can explore all the Climate Change Tools and download the full *Low Carbon Design Tools* at www.architecture.com/climatechange

Cover image Neal's Yard Remedies Headquarters, Gillingham, Dorset, Feilden Clegg Bradley Architects. The building is intended to be sustainable and energy-efficient. Energy use has been reduced by predominantly natural ventilation, with high levels of insulation, tight construction, good solar control, recycling and composting facilities. **Photo** Simon Doling for Feilden Clegg Bradley Architects

Introduction

The construction industry is facing increasing pressure to address environmental performance earlier in the design process. Planning permissions are more and more likely to require technical substantiations of how carbon dioxide emissions targets will be met.

Early and ongoing consideration of environmental performance leads to buildings that meet the required standards by the most cost effective methods.

There are many tools that may be used by the design team at different stages during the development of a project. Some cover all building types; others are specific to domestic or non-domestic buildings.

This summary guide highlights design tools that are available for architects designing low-carbon buildings and that are in common use in the UK.

Types of Design Tools

The major types of design tools are:

Calculation tools – for calculating, for example, thermal transmittances (U values) or linear thermal conductivities (ψ values).

Simulation tools – for predicting the performance of buildings, for example, Standard Assessment Procedure (SAP) energy rating software.

Dynamic simulation tools – for modelling the effect on performance of the thermal capacity (thermal mass) of the building fabric.

Sizing tools – for building services, including renewable energy systems.

It is important to distinguish between design tools of the above types and compliance checking tools, which use calculation procedures to check compliance with performance standards such as Building Regulations.

Using Design Tools

A really useful design tool does not need to be highly accurate. It supplements the designer's own knowledge by quickly confirming whether proposed changes to a design are likely to make performance better or worse and by indicating the relative effects on performance of different design features.

Before using any design tool, it is good practice to spend some time listing the design issues that need to be addressed, and then to select the appropriate design tool for each task.

All design tools, from simple calculation procedures to complex simulation models are simply means of estimating the approximate performance of a given design.

When using design tools to support the design of a low carbon building, you should adopt a staged approach, with the complexity of simulation increasing in proportion to the complexity of the design.

Early Guidance Tools for the Pre-Planning Stage

Good design decisions at an early stage can demonstrate a constructive approach to planning requirements and greatly reduce the risk of costly later revisions.

A growing number of tools is available to aid design teams in embedding low carbon design principles from the start of the design process, usually to understand the impact of Building Regulations or planning requirements.

Tools for Supporting Applications for Planning Permission

It is essential to consider energy efficiency first (i.e. reducing fuel demand), then shared energy supply (e.g. district heating or communal boilers), then finally renewable energy systems.

There are several tools that are used to demonstrate compliance with planning requirements and that are commonly accepted by planning authorities. These tools can be used to make initial estimates of the carbon dioxide emissions from energy use in proposed developments and to demonstrate the reductions that may be achieved from demand reduction measures and from using new/renewable energy systems.

Building Regulations Compliance Tools

Building Regulations compliance tools simulate the performance of a building to demonstrate that predicted carbon dioxide emissions are within the targets embodied in the Regulations. They use data on the final design and specification of the building, including the building fabric and services. They generate reports and performance certificates that form part of the application for approval of the design under the Building Regulations.

These tools must be approved and, in many cases, the person carrying out the assessment must also be accredited.

Low Carbon Design Tools for the Domestic Sector

Domestic Energy Rating

The most useful low carbon design tool for housing projects, both new and existing dwellings, is domestic energy rating software.

Building Research Establishment Domestic Energy Model

All domestic energy ratings use the Building Research Establishment Domestic Energy Model (BREDEM) to predict annual fuel use, fuel costs and carbon dioxide emissions under the same standard occupancy pattern.

Some energy rating software will also predict fuel use, fuel costs and carbon dioxide emissions under specified occupancy. Specified occupancy is useful for predicting households' actual costs and ensuring the availability of affordable warmth.

BREDEM is a well tested model that predicts total annual fuel use (for heating, hot water, cooking, lighting and appliances) under standard occupancy to an accuracy of ±5% in 95% of cases.

National Home Energy Rating

The National Home Energy Rating (NHER) is the leading domestic energy rating scheme. See www.nher.co.uk

The NHER of a dwelling is based on the estimated total annual fuel use (for space heating, water heating, cooking, lighting and the use of appliances), per square metre of floorspace, under standard occupancy. It is expressed on a scale of 0 to 20. NHER assessments are location-dependent, so for example three identical dwellings in Cornwall, Cheshire and Caithness will all have different NHERs, depending on the regional climate and the exposure of the site. All NHER software also delivers the SAP energy rating.

Standard Assessment Procedure (SAP)

The Standard Assessment Procedure (SAP 2005) energy rating is the Government's preferred domestic energy rating.

The SAP of a dwelling is based on the annual fuel use for space heating, water heating and fixed internal lighting only, per square metre of floorspace, under standard occupancy. It is expressed on a scale of 1 to 100+. Dwellings with SAP energy ratings greater than 100 are net energy exporters (due to local microgeneration).

SAP energy ratings are independent of location. This means that three identical dwellings built in Cornwall, Cheshire and Caithness all have the same SAP. Thus the SAP does not provide reliable predictions of occupants' fuel costs or of the availability of affordable warmth.

There are many suppliers of SAP software – for a full list of approved SAP software. See www.bre.co.uk/sap2005

Domestic Tools for the Pre-Planning Stage

At the pre-planning and early design stages, the design team must address low carbon principles. As design information is often limited at this stage, checklists and good practice guides are commonly used to identify design considerations that will influence the eventual performance of the development.

The Housing Energy Best Practice Programme is managed by the Energy Saving Trust and has published a large number of guides and case studies. See www.energysavingtrust.org.uk/housingbuildings/publications

Tools to Support Domestic Planning Submissions

The following tools may be used to demonstrate carbon performance at the planning application stage:

Integrating Renewable Energy into New Developments: Toolkit for Planners, Developers and Consultants (2004) is a paper-based tool to assess the feasibility of renewable energy systems and to assist developers and design teams in achieving Mayor of London and related borough planning policies.

Low Carbon Designer (to be released shortly) is a software tool following on from the Toolkit above.

Good quality SAP energy rating software can often be used to support planning submissions and demonstrate compliance with minimum renewable energy contribution requirements. The software can be used to estimate annual fuel use, fuel costs and carbon dioxide emissions of conventional building services, and then to identify the most cost effective renewable energy technologies and assess their potential contributions to the overall energy demand.

Domestic Compliance Tools

SAP energy rating software is the principal design tool for demonstrating compliance with the Building Regulations (and devolved equivalents) and with the energy credits of the Code for Sustainable Homes.

Good quality SAP software such as NHER Plan Assessor allows the designer to evaluate and compare specification options. Once a compliant specification has been identified the software will print a detailed compliance report and/or energy performance certificate for submission to the building control body or Code for Sustainable Homes assessor, or for issue in accordance with the requirements of the Energy Performance of Buildings Directive.

The Passive House Planning Package (PHPP) was developed by the PassivHaus Institute as a method of certifying performance against the Passive House Standard that is emerging as the pan-European standard for low carbon houses.

Domestic energy performance assessments are sensitive to the thermal transmittances (U values) of the building fabric elements, so it is important that accurate U values are calculated, by means of appropriate software. Such software includes:

- NHER U value calculator, supplied by National Energy Services (and bundled with NHER Plan Assessor)
- BRE U value calculator www.bre.co.uk
- Uvaluate, available from the insulation company Xtratherm UK Ltd
- BuildDesk U www.builddesk.co.uk

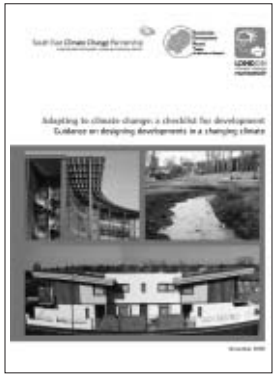
Low Carbon Tools for the Non-Domestic Sector

Non-Domestic Tools for the Pre Planning Stage

At the pre-planning and early design stages the design team must address low carbon principles and work these into the scheme alongside all of the other development requirements and constraints.

As design information is often limited at this stage, checklists and good practice guides are commonly used to identify design considerations that will influence the eventual performance of the development.

The Carbon Trust administers the Government's non-domestic Energy Efficiency Best Practice Programme and Action Energy, providing guidance on energy saving in the non-domestic sector. www.carbontrust.co.uk



CIBSE Guide to Energy Efficiency, Guide F (2004) – This guide highlights the opportunities to save energy in buildings in both design and operation and includes a useful design checklist, 'How to carry out an energy survey'. It has been written with architects, as well as building services engineers, as part of the target audience. www.tinyurl.com/yo6k4a

Adapting to Climate Change: A checklist for Development (2005) – A useful checklist to highlight the need for developments to be 'climate proofed', i.e. well adapted to our changing climate. www.tinyurl.com/2tezmc

Non-Domestic Tools to Support Planning Submissions

The following tools may be used to demonstrate carbon performance at the planning application stage:

Integrating Renewable Energy into New Developments: Toolkit for Planners, Developers and Consultants (2004) is a paper-based tool to assess the feasibility of renewable energy systems and to assist developers and design teams in achieving Mayor of London and related borough planning policies.

Low Carbon Designer (to be released shortly) is a software tool following on from the Toolkit above. This tool will offer a sequential, prescribed procedure for showing planning authorities the low carbon features that have been considered as part of a design, and the output report is suitable for inclusion with an application for planning permission. This tool will also facilitate detailed studies to substantiate environmental performance claims at the planning stage.

Non-Domestic Building Regulations Compliance Tools

The Simplified Building Energy Method (SBEM) is the only tool that may be used to demonstrate compliance with the requirements of Part L2A of the Building Regulations.

SBEM predicts the annual energy use and the associated carbon dioxide emissions of the proposed building and compares them with those of a notional building from which a maximum emissions target is established.

iSBEM is the user interface to SBEM, where the user enters the relevant building data and generates standardised performance reports to demonstrate compliance, and which should form part of the application for approval under the Building Regulations. Other commercially developed interfaces for SBEM are now available, including:

- Carbon Checker – a bespoke, accredited piece of software using the SBEM calculation engine at its core. Carbon Checker is based around a 2D/3D graphic interface, where the building can be drawn and checked visually. It also allows the user to import CAD files and physically trace over them. A number of 'runs' may be compared, so the user can look

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at the effects of different design scenarios. Carbon Checker is regularly updated in line with the latest versions of SBEM www.builddesk.co.uk

- **Ecotect** – this tool provides facilities to help designers understand environmental issues for a particular site and then assess combined energy use, thermal and lighting performance www.squ1.com/products
- **DesignBuilder** – this tool has been developed to help designers understand the performance associated with different design and building services options.
- **Hevacomp** – a set of building services design software tools bundled together as a number of packages to suit a variety of users. One of the modules is an accredited Building Regulations Part L2 compliance checker (incorporating SBEM) www.hevacomp.com
- **Tas** – a set of tools which features graphical data entry and provides dynamic thermal simulation of a building and its services. Tas uses its own Department for Communities and Local Government accredited calculation engine (not SBEM), and may be used to demonstrate Building Regulations Part L2 compliance www.edsl.net
- **IES Virtual Environment** – a range of software packages to provide complex building performance simulation. The IES Virtual Environment suite of thermal simulation packages enables the user to predict carbon dioxide emissions www.iesve.com

The **Passive House Planning Package** can also be applied to small and medium-sized non-domestic buildings.

Building energy performance assessments are sensitive to the thermal transmittances (U values) of the building fabric elements, so it is important that accurate U values are calculated, by means of appropriate software, such as:

- BRE U value calculator www.bre.co.uk
- Uvaluate, available from the insulation company Xtratherm UK Ltd
- BuildDesk U www.builddesk.co.uk

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