The Environmental Design Pocketbook

SOFIE PELSMAKERS

The Environmental Design Pocketbook places the information you need for sustainable, low-energy building design at your fingertips.

Packed with diagrams, tools, and tips, it cuts through the complex mass of technical data and legislation that faces the designer, and distils all the key guidance into a single reference that is quick and easy to use. Pointing to the facts, figures, and performance data that are most important, it includes:

- succinct guidance on all core sustainability topics
- concise explanations and reference to the latest legislation and codes
- invaluable checklists
- handy tools that allow you to quickly estimate the values relevant to *your* design
- design guidance, technology, building science, and best practice.

Twelve sections guide the designer from the fundamentals through to the building details themselves. From future-proofing for a changing climate to rainwater harvesting, retrofit, and zero-carbon technologies – the *Pocketbook* has got it covered.

Written for architects, as well as engineers, planners, clients and developers, this handy new pocketbook will help the professional designer to meet and exceed sustainable standards.

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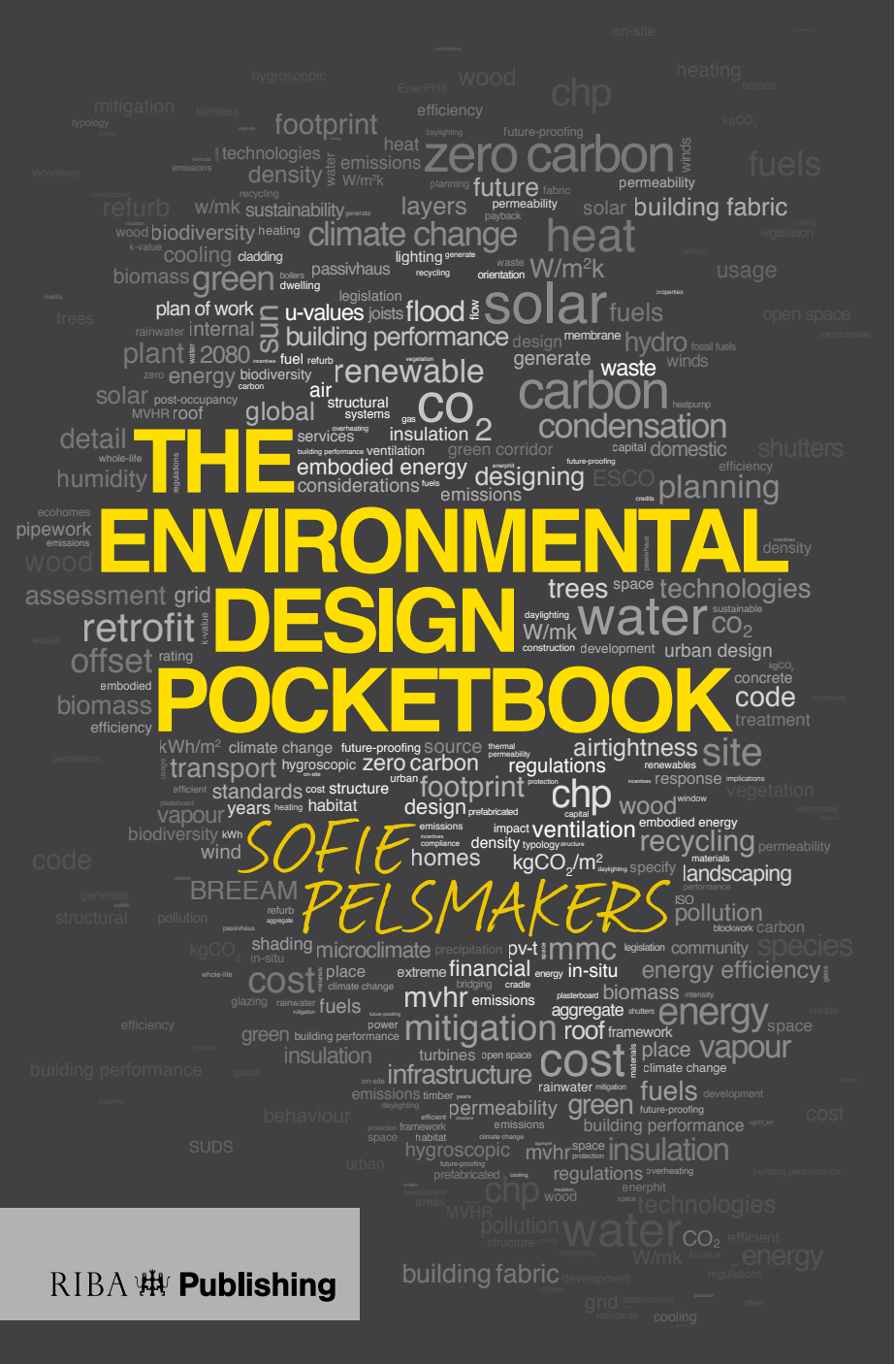

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Chapter 1

CO_2, climate change mitigation and the building industry

The construction and operation of buildings and cities accounts for around 50% of the UK's CO_2 emissions and is thus a significant contributor to global warming. A reduction in CO_2 is needed to mitigate climate change, and this reduction is the main driver behind many building-specific EU and UK regulations, codes and frameworks.

However, CO_2 emissions are not the building industry's only environmental impact. Other impacts include loss of biodiversity, resource depletion and negative effects on building users' health and well-being.

This introductory chapter gives a brief overview of the main causes of global warming. It looks at climate change mitigation policies and frameworks, particularly CO_2 reduction targets. The chapter also discusses the challenges to CO_2 reduction posed by unpredictable 'human factors' and how building designers can meet them. Finally, a checklist accompanying the RIBA Work Stages is included.

While this chapter sets out climate change mitigation measures, the succeeding chapter covers climate change impacts and adaptation measures.

Symbol indicates relevance to the Code for Sustainable Homes, EcoHomes & BREEAM.

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Chapter 2

Design strategies and adaptations for a changing climate

Despite even the best mitigation efforts, our climate is experiencing irreversible changes.

Buildings are usually designed with a lifespan of around 60 years. What we build today will still be standing in 2080 and beyond, and we must design for the climate change predicted during that period. We must also carefully consider our reliance on finite resources which move closer to exhaustion by the day. Only in doing so are we able to fulfil our duty towards clients and building users.

Seasons in the UK, in general, are expected to become warmer. We will see drier summers, wetter winters and more extreme winds and rainfall. Although the increases in temperature are incremental, the actual impact on both the natural and the built environment is significant. As an island, the UK is particularly vulnerable to coastal flooding. Inland, extreme rainfall will increase the risk of urban flash floods and swollen rivers. We are also likely to experience more heat waves and droughts which could pose issues of subsidence and affect the way we cool buildings.

This chapter summarises predicted climatic changes and arising design implications and adaptations, both for site planning, building design and during construction.

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Environmental site planning

A building's performance is not only determined by local climate conditions and operational energy efficiency. Site location and urban design approach also have a major impact. Rather than working against the urban grain, we need to work with it by using environmental site planning principles; we can then promote occupant comfort and health as well as minimising operational and transportation energy use.

Instead of endlessly repeating historical patterns, site planning should respond to climate change predictions. This chapter considers the implications of a warmer climate and Chapter 5 discusses flood risk.

It is crucial to get the environmental basics right on the site. Then whoever 'plugs into' the urban grain in the future has a better chance of achieving high environmental building standards.

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Urban greenery and biodiversity

Biodiversity is an important facet of sustainable building, bringing social, economic and environmental benefits to any development. Not only can energy consumption in buildings be reduced by thoughtful planting, but urban greenery can also improve residents' well-being and provide a crucial habitat for local wildlife.

Provisions for biodiversity need to be carefully thought through, if the benefits are to be maximised. The positioning of vegetation in relation to buildings and green corridors needs to be closely considered, as does the type of vegetation. Native plants are essential for supporting indigenous wildlife habitats, while on the other hand some native plant species will not survive or thrive in a changing climate.

Urban vegetation also contributes to CO_2 sequestration. In addition, the principle of 'food miles' illustrates the carbon reductions that can be achieved by growing food locally.

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Water and flooding

Environmental design must work with water rather than against it. This is a primary consideration which will become even more important in a changing climate:

- Increased flooding due to extreme rainfall events is anticipated.
- At the same time, increased periods of drought and water shortages are expected.

Careful consideration is no longer a luxury: where to build, which building typology, how much land to set aside for water storage and which surface finishes are more resilient are now vital decisions for design. Allowing water run-off to soak-away on site instead of connection to sewers is nearly always the preferred option.

Water efficiency inside buildings is also starting to be regulated. Water-efficient appliances, rainwater harvesting systems and greywater recycling will eventually become embedded in building design. However, not all such systems are sustainable: it is energy intensive to treat and pump water around, and the embodied energy of the system can be significant.

Hence, careful building-specific design specification is required to avoid increasing carbon emissions in the quest to save precious water. Usually, connection to mains water supply and sewers is the most suitable option.

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The internal environment: space, warmth, light and air

Two key drivers are making consideration of a building's internal environment ever more vital: the changing climate and the increased thermal performance of the fabric from which the building is built.

The fact that we are operating in a changing climate can no longer be ignored. If buildings are not designed to cope, temperature-related health issues will become a significant problem and it is therefore critical that issues such as thermal comfort, natural ventilation, winter solar gain and summer solar shading are considered early on by the designer.

Equally, increased airtightness standards, controlled ventilation and even the impact of building fabric on space standards all mean that a careful approach is required to avoid compromising the quality of the internal environment.

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The building fabric

Taking steps to reduce a building's operational carbon footprint usually requires an increase in its embodied carbon footprint, owing to the increased amount of insulation material required. This 'investment' in a higher carbon footprint will soon pay off if the building is carefully designed and constructed for long life, ease of maintenance, deconstruction and reuse.

Materials and construction methods may be chosen according to:

- aesthetics
- costs
- availability
- robustness
- material performance, e.g. acoustics and structural strength

When specifying the fabric of a sustainable building, the designer should also prioritise:

- life-cycle assessment and embodied carbon of materials, including designing for deconstruction and reuse
- thermal performance
- air, vapour and water permeability
- impact on internal air quality

This chapter explores the latter in more detail. The focus is on mainstream building techniques and materials suitable in the UK.

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Retrofit of existing housing stock

There are around 26 million dwellings in the UK,[1] 80% of which will still exist in 2050.[2] At present, these dwellings represent around 27% of the UK's CO_2 emissions.[3]

Around 7.6 million are solid walled properties.[4] One solid walled property needs about the same amount of space heating as eight dwellings of the same size built to current Building Regulations. This illustrates both the necessity and the potential impact of retrofitting the existing housing stock.

Yet, so far, less than 1%[5] of solid walled dwellings have been insulated, and no UK regulations deal with the refurbishment of existing housing stock. However, the 2008 Climate Change Act aims to make the entire UK housing stock zero or low carbon by 2050.[6]

By simply refurbishing to much higher insulation and airtightness standards, carbon reductions of at least 40% can be achieved. This would reduce the operational energy required just to heat our buildings by at least 80%.

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Key details

This chapter contains key details to illustrate good practice concerning insulation placement, airtightness zones and minimising thermal bridging. These details include some typical retrofit junctions as well as green roofs. The airtightness recommendations and principles in Section 7.4 need to be applied to all of the details at both design and construction stage.

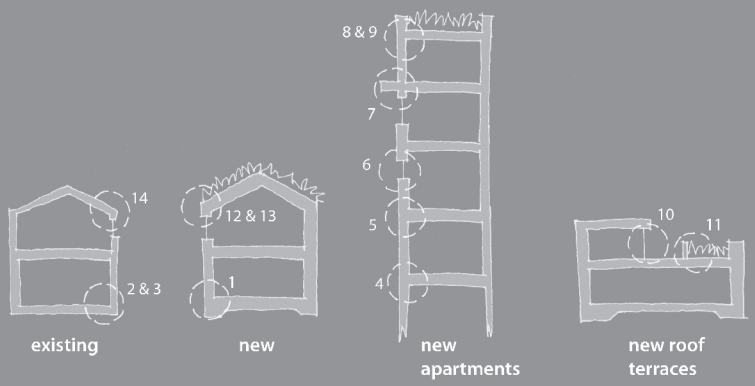

Fig. 9.1 The locations of key details 1–14 on both new and existing buildings

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Chapter 10

Energy supply and demand

Energy supply is often wrongly considered to be the most important issue in delivering low carbon buildings.

In fact, the priority is to reduce energy demand.

When considering energy supply and demand, a clear hierarchy exists:

1. Fabric energy efficiency is always the first 'renewable' to consider as opposed to trying to meet a building's large energy demand.
2. Once reduced, it is easier to meet any remaining energy demand, which should be met using efficient methods. This avoids wasting energy in transmission, even if it is energy from 'low carbon' sources.
3. Low carbon energy supply should only be considered once the above strategies have been maximised.

The preceding chapters have focused on the first point and set out strategies to reduce energy demand in buildings.

This chapter relates to operational energy and operational carbon from buildings. It summarises the energy demands of different building typologies. It investigates efficient methods of delivering energy, such as underfloor heating, use of A-rated appliances and local energy generation from district heating schemes.

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Chapter 11

Zero carbon buildings

0 CO_2

The zero carbon definition is still being developed at the time of writing. England has made the most progress with its zero carbon definition for housing and so it is this standard which is used in this chapter.

By 2020, all new UK buildings must meet the zero carbon standard. At present this means that 100% of a building's regulated carbon emissions are to be reduced to 'zero' over a 30-year life. This is achieved through:

1. increased fabric energy efficiency standards (FEES)
   → Jump to Section 7.5.2
2. on-site energy supply (low and zero carbon technologies)
   → Jump to Chapter 12
3. 'allowable solutions', which could be a combination of the above, or other off-site measures, and this may include payment per tonne of remaining CO_2 emissions (see Section 11.1.3)

Steps 1 and 2 are called 'carbon compliance'.
A simple zero carbon calculator is provided so that the reader may roughly estimate a development's zero carbon feasibility.

The zero carbon standard is continuously evolving, so the reader should always check for the latest updates:
Scotland: www.scotland.gov.uk/Topics/Built-Environment/
England: www.zerocarbonhub.org
Wales: www.sustainablebuildingportal.co.uk
Northern Ireland: www.theccc.org.uk/topics/uk-and-regions/northern-ireland

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Chapter 12

Low and zero carbon technologies and renewables

Renewable energy is energy that comes from inexhaustible sources. It usually originates directly or indirectly from the sun's radiation.

Not all technologies which offer significant environmental benefits over the use of conventional fossil fuels fall into this category. This is why the term 'low and zero carbon technologies' (LZC) is often used instead of 'renewable energy technologies'.

Low and zero carbon technologies are often incorrectly seen as fundamental to 'green buildings'. In fact, reducing energy demand is the priority when delivering low carbon buildings.

Suitable 'clean' energy sources should be discussed early on as part of a holistic strategy, but only utilised after maximising energy savings from passive measures and fabric efficiencies.

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