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Routledge
Taylor & Francis Group
LONDON AND NEW YORK

First published 2012
by Routledge
2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN

Simultaneously published in the USA and Canada
by Routledge
711 Third Avenue, New York, NY 10017

Routledge is an imprint of the Taylor & Francis Group, an informa business

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

Library of Congress Cataloging in Publication Data
Emmanuel, Rohinton.
Carbon management in the built environment /
Rohinton Emmanuel, Keith Baker.
p. cm.
Includes bibliographical references and index.
1. Sustainable buildings. 2. Sustainable construction.
I. Baker, Keith, 1979– II. Title.
TH880.E485 2012
690.028'6 dc23
2011050648

ISBN: 978–0–415–68406–4 (hbk)
ISBN: 978–0–415–68407–1 (pbk)
ISBN: 978–0–203–80331–8 (ebk)

Typeset in Garamond
by Swales & Willis Ltd, Exeter, Devon

Printed and bound in Great Britain by
TJ International Ltd, Padstow, Cornwall

Carbon Management in the Built Environment

Three broad sectors of the economy are generally recognised as key to a low carbon future: energy, construction and transportation. Of these, carbon management in the built environment remains the least well studied.

This much-needed book brings together the latest developments in the field of climate change science, building design, materials science, energy and policy in a form readily accessible to both students of the built environment and practitioners. Although several books exist in the broad area of carbon management, this is the first to bring together carbon management technology, technique and policy as they apply to the building sector.

Clear and succinct sections on the overarching principles, policies, approaches and technologies are combined with case studies and more in-depth coverage of the most relevant topics. It explains how to produce a simple carbon footprint calculation, while also being an informative guide for those developing or implementing more advanced approaches. This easy to read book is the ideal primer for anyone needing to get to grips with carbon management in the built environment.

Rohinton Emmanuel is a Reader in Sustainable Design and Construction and the Director of the Centre for Energy and the Built Environment at Glasgow Caledonian University, UK. He has pioneered the inquiry of urban climate change in warm regions and has taught and consulted on climate and environment sensitive design, building energy efficiency, thermal comfort. He has authored over 50 research papers in the areas of climate change in the built environment, building and urban energy efficiency and thermal comfort, and a book related to these efforts, *An Urban Approach to Climate Sensitive Design: Strategies for the Tropics*, was published by Routledge in 2005.

Keith Baker is a Researcher in Sustainable Urban Environments at the Centre for Energy and the Built Environment at Glasgow Caledonian University, UK. He is also a member of the Scottish Carbon Accounting Group, and currently directs Sustainable Footprints, a carbon and sustainability management consultancy. Keith's main research interests are in climate change, energy, the built environment, and the environmental impact of technology.

To Melanie and Cindy
For your many sacrifices that made our task light

Foreword

This is a very welcome book indeed: a clear, comprehensible and sensible book on the complex subject of carbon accounting and management in the built environment will help a generation of building designers and managers to come to grips with how, in reality, to reduce energy emissions from both new and existing buildings. The oft repeated maxim that we have all seen many low carbon building designs, but very few really low carbon buildings, does hold true. This book, which explains the key carbon issues and methods as applied to the built environment, is important in informing the way we move on from the high energy, high carbon, twentieth-century business-as-usual approaches to urban design and towards the low carbon buildings so essential for a safer future in the difficult decades ahead.

I believe that the division of the design professions in the twentieth century into silos of responsibility has had devastating effects on the quality and performance of the buildings we produce. Many of the generation of young architects now leave universities around the world being unable to design basic buildings, let alone low carbon ones. A generation of building services engineers were not even taught how to shape and design low energy, passive buildings that could be naturally ventilated, in the push to get more and more servicing 'product' into buildings. In the UK and elsewhere the entire building regulation system is riddled with perverse incentives that discourage truly low carbon design – as evidenced by the UK building regulations that enable a simple office design to pass their standards while the same naturally ventilated office on a green-field site will fail. The results of such wrongly facing trends can be seen on the high streets of cities around the world, and a growing number of buildings built two, three or four decades ago are already being pulled down today, or lie empty awaiting some uncertain fate.

This book is part of the new, universal language of low carbon building design and management. It is an important book for that. It explains why the transition to low carbon built environments is so important, the international landscape of action, and the regulation that drives the groundswell of change in our industry that affects us all. Whether you are a climate change sceptic or believer, you now have to know about how to count and account for carbon, and how to design and manage buildings to reduce carbon emissions from them. This book tells you how.

Fundamental to how we design our buildings and their systems to reduce energy and related emissions is *why* we do so. A vital strand to the language of low carbon buildings is a re-evaluation of comfort and how to achieve it in low carbon buildings and the understanding of comfort as a goal for good design as opposed to a product produced by machines. Another strand is the inclusion of a wide range of new issues into the way we account for the carbon of a development, including transport, waste and many other constituent elements of a development that must now be accounted for in assessing the carbon impacts of buildings.

That is why I am so pleased that this book has been written to provide a first rate and eminently usable guide to carbon accounting and management. Carbon accounting and management, used

to baseline and benchmark emissions in a process of continual performance improvement, provide the glue that sticks together the disparate issues in the final building account. Trust me – the issues are complex, as we have found out in ICARB, the Initiative for Carbon Accounting, in which the authors of this book have also played a major part.

But it is not only students on specialist low carbon building design and management courses who will be able to use this as their course textbook of choice, but undergraduates and all design professionals, whether architects or engineers, because carbon management is a core strand of the new language of low carbon buildings, and we all need to learn and share that language.

Susan Roaf
Professor of Architecture, Heriot-Watt University,
and founder of the Initiative for Carbon Accounting (ICARB)
December 2011

Preface

This handbook is our first attempt to provide an overview of the many issues around managing carbon and greenhouse gases in the built environment, and we hope it will be useful as a primer for anyone new to the field and a reference guide for students and professionals alike. The hardest part of writing this book has been trying to strike the best balance between the scope and the depth of the coverage, and because of this some of the final contents have changed somewhat from our initial ideas. We hope these changes have been for the better in enabling a more specific coverage of the issues most relevant to the built environment, and we welcome any feedback for future editions.

The opening section of the book summarises the contexts in which those working to reduce emissions from the built environment operate – from global governance and climate change down to the more practical issues around reducing emissions from the built environment. The second section presents a more detailed coverage of these latter issues and how they may be addressed in specific built environmental contexts (new build, existing build and cities). By opening this section with energy generation we underline the ultimate dependence of all emissions reduction targets on decarbonising our energy supplies. The final section covers many of the protocols, standards, approaches, methods, tools and techniques that can, or must, be adhered to or employed as part of assessing energy consumption in the built environment and the emissions attributable to it. Identifying and selecting the most relevant of these have been a daunting task, and we apologise for any omissions and being mainly limited to English language sources.

Although we have included some illustrative case studies, it was never our intention to provide a template example for use in carbon and greenhouse gas accounting. In reality carbon and GHG assessments (or 'footprints') vary widely according to factors such as their subjects, aims, methods, tools, results and outputs, as well as any legislative requirements they are subject to – and any template would rapidly become out of date. Similarly, whilst there are many perfectly good commercial carbon accounting tools and services on the market we have not attempted to summarise or recommend any of these; not only will different projects require different tools, but also different users will judge those available on different criteria. However, we hope this handbook contains sufficient guidance and pointers to key publications to enable the development of carbon and GHG assessments for most common aspects of the built environment, whether users decide to use existing tools or develop their own.

Carbon and GHG management is a rapidly evolving, complex and contested field, and we are conscious that by even writing about some issues we are opening ourselves to accusations of bias. The issue of energy generation provides a case in point. The options for the scope of what to include in this chapter ranged from limiting it to building-integrated technologies up to a full coverage of all existing and possible future generation technologies. As with carbon and GHG accounting, the key problem was deciding where to set the boundaries. We have avoided

discussing future technologies because of the uncertainties around them, and also because the urgent need to tackle climate change means that we should not let predictions of the potential of future technologies cloud our judgements over decisions that must be based on what works today. We could have also dodged the bullet of nuclear power by limiting our scope in a number of ways, but all of these would have required omitting other technologies which are also contributing to reducing emissions from the built environment.

A more building-specific issue that can provoke heated debate is providing heating, ventilation and air conditioning (HVAC). It is difficult to work in this field and not become an advocate of one or more approaches to meeting these demands. However, regardless of whether you favour passive or mechanical ventilation, or high thermal mass or light build, the priority should be identifying the most effective solutions in any given context. The same applies to identifying the most appropriate options for retrofitting buildings for energy efficiency: there is no one-size-fits-all approach, but some approaches are more generally applicable than others, and conversely some buildings are more individual than others. Identifying and implementing those solutions require pulling together the best available evidence, and we hope that this book will be a useful aid for doing so.

In 2004 the GHG Protocols Group set out five key principles of carbon accounting: relevance, consistency, completeness, transparency and accuracy. So how well do we think this text compares against them? With so much information that could be captured we'd never claim it was 100 per cent complete, and its accuracy will decline as the latest information changes over time, but we hope readers find it relevant and consistent, and we have done our utmost to ensure that it's transparent. We hope you'll find it useful, and we leave you with a little bit of satire for when the going gets tough and the figures simply refuse to add up.

R. Emmanuel and K. Baker
Glasgow, December 2011

A Carbon Accountant's Completely Perfect and Absolutely Quantitative Method of Measuring His Emissions

By Keith Baker – with apologies to R. Landon and A. Bueche

I change our energy bills to carbon with factors I can't deduce,
Differentiate by consumption, determine frequency of use;
Where uncertainty arises I simply calculate the mean,
(And then deduct a small percentage for electricity that's green).

I integrate our recycling rate upon a monthly basis;
Calculate just what our place in the race to zero waste is;
And our emissions inventory has boundary conditions,
Whose final calibration is the Company's net emissions.

And thus I create numbers where there were none before;
I have lots of facts and figures – and formulae galore –
And these quantitative studies make the whole thing crystal clear,
Our emissions will be exactly 10 per cent lower than last year.

Acknowledgements

A comprehensive text on carbon management specifically focused on the built environment does not exist at present. Our efforts therefore relied on many friends and colleagues for intellectual stimulation, sources of information, and discussion and debate. We are particularly indebted to Tony Kilpatrick, Head, Department of Construction and Surveying, School of Engineering and Built Environment, Glasgow Caledonian University, for allowing us the time to write the book, and to our colleagues: Drs Paul Baker, Ole Pahl, Mark Phillipson, Paul Teedon and Craig Thomson. We are honoured to have Professor Sue Roaf, Heriot-Watt University, Edinburgh, writing the Foreword and, together with Sam Chapman and Richard Roaf, for providing encouragement and advice via the Initiative for Carbon (ICARB), Edinburgh. Dr Liz Hawkins, Community Analytical Services, Scottish Government, directed us to many useful sources in Scotland. All help provided by Gary Davis, Director, Ecometrica, Edinburgh and Montreal, Scott Herbert, University of Leicester, England, and Professor Katherine Irvine and Professor Mark Rylatt, De Montfort University, Leicester, England, is gratefully acknowledged.

We are indebted to the following for kind permission to reproduce illustrations used in the book: Figure 1.1 (Intergovernmental Panel on Climate Change, Working Group III, World Meteorological Organization; Ms Sophie Schingemann); Figure 2.2 (World Resources Institute, Washington, DC, USA, Office of Science and Research: Ms Ashleigh Rich); Figure 2.3 (Global Commons Initiative: Aubrey Meyer); Figure 2.4 (Professor Aviel Verbruggen, University of Antwerp, Belgium); Figure 2.5 (UNEP/GRID-Arendal); Figure 2.6 (Global Carbon Project: Dr Josep Canadell); Figure 3.1 (Scottish Government, Soils and Contaminated Land Team, Environmental Quality Division: Mr Francis Brewis); Figure 3.3 (Department for Energy and Climate Change: Ms Lisa Ahmad; and Department for Environment, Food and Rural Affairs, Press Office, Communications Group: Mr Paul Leat); Figure 5.2 (University of Veterinary Medicine Vienna, Biometeorology and Mathematical Epidemiology Group, Institute for Veterinary Public Health: Professor Franz Rubel); Figure 6.1 (University of Moratuwa, Sri Lanka, Department of Civil Engineering: Professor Thishan Jayasinghe); Figure 10.2 (Scottish Government, Scottish Buildings Standards Agency: Dr Fraser Walsh). The following gave us permission to reproduce photographs, for which we are very grateful: Mr Chris Morgan, Locate Architects, Dunblane, Scotland (Figure 5.7 and cover photo); Mr Vidhura Ralapanawe, MAS Thurulie Ltd, Sri Lanka (Figure 5.8); Dr Hans Rosenlund, CEC Design, Sweden (Figures 5.9 and 5.10); Ms Veronica Olivotto, Institute for Housing and Urban Development Studies (IHS), Erasmus University, Rotterdam, and Dr Denis Fan, Faculty of Technology, De Montfort University, Leicester, England (Figure 8.2).

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