

<b>Institution: University of Lincoln</b>
<b>Unit of Assessment: 16 Architecture, Built Environment &amp; Planning</b>
<b>Title of case study:</b> Design and development of carbon reduction management frameworks and tools
<p><b>1. Summary of the impact</b></p> <p>The research reported in this case study demonstrates that in order to achieve a carbon neutral future whole life building carbon footprinting should be undertaken by using Life Cycle Assessments (LCA) at all stages of design, construction and throughout the lifespan of buildings. Practical tools in this area are few, and the award winning research projects reported here address this need and have had impacts in the following areas; firstly, through their direct applications in building procurement and management, secondly through changes to national standards and specifications and thus professional practice, and thirdly through enhanced public awareness at local, national and international levels.</p>
<p><b>2. Underpinning research</b></p> <p>The underpinning research on carbon footprinting of buildings commenced in 2007 and is ongoing. The research examines the complete building lifecycle that can be understood for the purpose of carbon footprinting as having three distinct stages, namely initial impact, operational impact, and end of life impact.</p> <p><b>2.1 Context of the research:</b> Carbon Dioxide (CO<sub>2</sub>) has become the currency of UK environmental marketing. The construction industry has become increasingly concerned about understanding the impact of buildings as different stakeholders in the industry are shifting their focus towards declaration of the greenhouse gas (GHG) emissions and carbon footprints of buildings, with an ultimate goal to become carbon neutral or even carbon positive.</p> <p><b>2.2 Current research gaps and how this research addresses them:</b> Calculating emissions from the construction process and building use is a relatively new concern for the construction industry and published sources are limited. There are a number of carbon management tools available, however, not many of them apply the life cycle approach and few are suitable for use by the construction industry, mainly due to their different calculation methodology and region specific datasets. There is no viable standard toolkit.</p> <p>The research reported in this case study establishes two frameworks. The first framework proposes an assimilation methodology and toolkit with data, scope and boundary protocols to allow comparison of design scenarios within building type groups. The second framework offers a predictive modelling toolkit designed to help organisations with large property portfolios to reduce their carbon emissions. The frameworks support the formulation of environmental impact reduction strategies throughout the design, construction and management of buildings and support life cycle thinking in terms of design life, reuse and recycling necessary for optimising sustainability in the built environment.</p> <p>The Centre for Architectural Research in the Lincoln School of Architecture has developed the methodologies, frameworks and toolkits in partnership with industrial partners. They provide the construction industry with consistent approaches in order that benchmarks can be established and proposed design and buildings may be more readily compared and analysed. The research has inspired audiences to become increasingly aware of their carbon footprint, and to understand the changes that need to be made to our built environment to achieve a more sustainable future.</p> <p><b>2.3 Research objectives and aims</b></p> <ol style="list-style-type: none"> <li>1. To propose calculation methodologies and data collection procedures to ensure uniformity, consistency, transparency and accuracy in estimation of the carbon emissions of buildings.</li> <li>2. To enable design teams and facility managers to create and maintain low emission buildings across the whole life cycle of buildings.</li> </ol>

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3. To enable best value cost benefit decision making alongside low carbon and other sustainability drivers.

**2.4 Research methodology:** Life cycle assessment (LCA) is a systematic approach to manage the potential environmental impacts of products and service systems. This philosophy towards meeting changing needs and mitigating risks can be compared to the research methodology of *experiential learning*. Precedent for this form of research design is rooted in the development of *Change Theory* in which the researcher is engaged in a reflective study of professional practice within a system, in the case for this impact case study, large architectural practices and organisations with large property portfolios. This research is also linked to the idea of pragmatic *Action Research*, which would be apparent in the implementation of the change to the collaborating professional practices that would be brought about by wide-scale adoption of good practice.

**2.5 Key research findings:** The research has produced a family of carbon reduction management tools. Two selected tools are outlined here as examples;

The Carbon Lifecycle Evaluation Assimilation Framework – Carbon Leaf

This toolkit was developed as part of a two-year KTP research project (2007-09) in association with Simons Group. The KTP Partnership has been graded ‘Very Good’ by a panel of independent Assessors. The developed framework and its associated design toolkit have been used widely by that company to model building carbon footprint during the design process.

Carbon4CAST, a Carbon Action Strategy Toolkit

The toolkit was developed in association with NPS Humber Ltd as part of a two-year KTP research project (2011-13). The KTP Partnership has been graded ‘Outstanding’, the highest rating possible, by a panel of independent Assessors. Carbon4CAST is a toolkit developed to assist businesses with large or complex property portfolios in their commitment to reduce carbon emissions. The tool received the esteemed award for innovation at Ecobuild 2013.

Among research findings are;

- Recognise and understand business’s impacts
- Deal with biggest impacts first
- Design to manage both social and environmental impact
- Work with all stakeholders to continuously improve sustainable practice

**2.6 Research team:** The on going research that underpins this case study was initiated as part of two Knowledge Transfer Partnership research grants whose outputs are widely recognised and which have won prestigious awards. The KTP with Simons Group (KTP006662, value £113,696) was supervised by Prof. Sodagar, Prof. Chilton and Philip Hyde (Chilton left the University of Lincoln in 2008). The industrial supervisor was Dr Rosi Fieldson of Simons Group. The KTP research associate was Deepak Rai. The KTP with NPS Ltd (KTP008021, value £110,000) was supervised by Prof. Sodagar, Dr Elnokaly and Simone Medio. The industrial supervisor was John Bell, while Dr Feifei Sun was the KTP associate.

### 3. References to the research

- Sun, F., Sodagar, B. and Bell, J. (2013) Building Heating Consumptions under Present and Future Climate Scenarios, conference paper presented at PLEA2013-29<sup>th</sup> Conference, Sustainable Architecture for a Renewable Future, Munich, Germany, 10-12 September 2013.
- Sodagar, B., Rai, D., Jones, B., Wihan, J. and Fieldson, R. (2011) *The Carbon Reduction Potential of Strawbale Housing*, Building Research & Information, Volume 39, Issue 1, January 2011, pp. 51–65, Routledge, Taylor & Francis Group, ISSN 0961-3218.
- Rai, D., Sodagar, B., Fieldson, R. and Hu, X. (2011) *Assessment of CO<sub>2</sub> Emissions Reduction in a Distribution Warehouse*, The International Journal of Energy, Volume 36, Issue 4, April 2011, pp. 2271-2277, Elsevier, ISSN 0360-5442.
- Fieldson, R., Deepak, D. and Sodagar, B. (2009) *Towards a framework for early estimation of lifecycle carbon footprinting of buildings in the UK*, Construction Information Quarterly (CIQ) Journal, Chartered Institute of Building (CIOB), Volume 11, Issue 2, June , pp. 66-75.

## Impact case study (REF3b)

- Sodagar, B., Rai, D., Murphy, J. and Altan, H. (2009) *The role of eco-refurbishment in sustainable construction and built environment*, conference paper presented at 3<sup>rd</sup> CIB International Conference on Smart and Sustainable Built Environments (SASBE), June 15-19, 2009, Delft.
- Sodagar, B. and Fieldson R. (2008) Towards a low carbon construction practice. *Construction Information Quarterly (CIQ) Journal*, Chartered Institute of Building (CIOB), Volume 10, Issue 3, October, pp 101-108, ISSN 1469-4891.

### 4. Details of the impact

The impacts of the underpinning research have affected a wide range of beneficiaries at regional, national and international levels. The reach and significance of the impacts may be categorised as;

#### **Impacts on practitioners, professional services, local government and national specifications:**

Simons Group and NPS Ltd, acting as the industrial partners have directly benefited from the research and its outputs. For example, the Simons Group is using The Carbon Lifecycle Evaluation Assimilation Framework and its associated tool to benchmark projects at both feasibility and tender stage. Not only has this provided the Group with a useful aid in facilitating carbon conversations with their clients, it has enabled them to understand the impact of carbon in the projects they work on resulting in value engineering of both emissions and costs as stated in their website;

[http://www.simongroup.com/p/h/Building\\_Greener/Benchmarking\\_whole\\_life\\_carbon/512/?lang=](http://www.simongroup.com/p/h/Building_Greener/Benchmarking_whole_life_carbon/512/?lang=)

In November 2007, concurrently with the KTP project with Simons Group, Sodagar with five partners (Simons Group, Davis Langdon, dcarbon8, Delta Simons and Total Flow) founded the Construction Emission Community of Practice (CECoP). CECoP is an inclusive voluntary group of consultants and academics working collaboratively on developing the protocols for calculating and understanding the carbon footprint of buildings. CECoP won the Royal Institute of British Architects (RIBA) East Midlands Special Award in 2008 for Architecture celebrating excellence in the region. CECoP collaborated with the Carbon Trust and Defra during the consultation stage of the development process for "Specification for the assessment of the life cycle greenhouse gas emissions of goods and services" (PAS2050), a publicly available specification which came into effect on 29 October 2008 (BSI October 2008, ISBN 978 0 580 50978 0).

The impact of this research has gone beyond the immediate collaborative industrial partners. CECoP, for example, has organized a series of national symposia and one international conference targeting the industry to share and disseminate the research findings. These include;

- Timber Sequestration Symposium, 30<sup>th</sup> January 2009, Offices of Davis Langdon, London.
- Responsible Sourcing workshop, 22<sup>nd</sup> June 2009, Offices of Davis Langdon, London.
- Carbon Footprinting Symposium 1, 5<sup>th</sup> March 2008, Offices of Simons Group, Lincoln
- Carbon Footprinting Symposium 2, 2<sup>nd</sup> May 2008, Offices of Davis Langdon, London.
- Eco Deco Conference, 9<sup>th</sup> December 2008, University of Lincoln.

Impact has also been achieved internationally. Examples of this include the UK-China Innovation Forum on Sustainable Building Technologies, held in Beijing and Shanghai in June 2011, at which Sodagar, as the invited speaker, presented both the research and the design tools.

Carbon4CAST the innovative carbon management tool which has been created as part of the research carried out in collaboration with NPS Humber Ltd, employs a three-phase approach to help large organisations establish strategy plans, identify energy saving priorities, and optimise spending. It is currently being used to predict carbon emissions of Hull City Council's building portfolio (around 700 buildings). Following its success at the Ecobuild (see the following section), Carbon4CAST is utilised by NPS Humber Ltd to improve environmental performance of a range of their clients including large retail organisations. Carbon4CAST is also rolled out to 27 offices of NPS nationwide to accurately predict carbon emissions of their clients including city councils. NPS is involved in negotiations with Chinese central and local governments, including the Ministry of

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Energy and Climate Change, for the utilisation of Carbon4CAST to forecast and manage carbon reduction targets in China.

**Impact on raising awareness of the public:** The research has substantially raised public awareness and acceptance of the potential of carbon management tools in reducing environmental impacts of buildings. Carbon4CAST was showcased as part of the Innovation Future Zone at Ecobuild, 5-7 March 2013 alongside other industry-leading inventions. Following a national competition, the tool received the Innovation Award at Ecobuild 2013, sponsored by the Modern Build Environment Knowledge Transfer Network, a network of government organisations that brings together the latest developments in the built environment.

By invitation, Carbon4CAST was also exhibited at the Building Research Establishment (BRE) INSITE13 Conference and Exhibition on 2-3 October 2013. Here, the potential of the toolkit to predict and reduce carbon emissions was demonstrated to the construction industry, as it was showcased in the Exhibition Zone and the Innovation Park – renowned for profiling new and emerging technologies.

**Impacts on the environment:** The research has resulted in quantifiable carbon reductions of businesses and activities, which in turn reduce the impacts on environment. The Simons Group, for example, claims that during the period of research (2007-09) the Carbon Leaf has reduced their business carbon footprint by 25%, with much of this reduction being due to better planning for site energy needs and recording of site emissions, effectiveness of communicating transport policy, and energy awareness training.

**5. Sources to corroborate the impact**

- Innovation Award, Carbon4CAST, Carbon Action Strategy Toolkit, Ecobuild 2013.
- RIBA EM 2008 Award – Special Project Award, for Construction Emission Community of Practice (CECoP), 2008.

**Selected press coverage**

Award for new technology which predicts environmental impact of buildings

<http://www.lincoln.ac.uk/news/2013/03/659.asp>

Carbon 'crystal ball' boosts firms' drive to be greener, Lincolnshire Echo, 4 and 10 April 2013.

[www.thisislincolnshire.co.uk](http://www.thisislincolnshire.co.uk).

Hull & East Yorkshire (08/03/2013)

<http://www.hull.co.uk/news.asp?PageID=74&NewsID=3206>

Business link (22/3/2013)

[http://www.blmforum.net/en/blm/Environmental/2382/Carbon-capture-tool-wins-national-recognition.htm/?utm\\_source=newsletter&utm\\_medium=email&utm\\_campaign=mar25](http://www.blmforum.net/en/blm/Environmental/2382/Carbon-capture-tool-wins-national-recognition.htm/?utm_source=newsletter&utm_medium=email&utm_campaign=mar25)

Green Build News, Award for carbon management tool, March/April 2013,

[www.greenbuildnews.co.uk](http://www.greenbuildnews.co.uk).