Smart building: how digital technology can futureproof UK construction

Green Alliance, May 2020

Methodology

Analysis of embodied emissions reduction

The baseline embodied emissions for 2013 are calculated based on embodied emissions associated with buildings construction, as estimated by the Centre for Research into Energy Demand Solutions (CREDS) at the University of Leeds (36MtCO_2e).[1] These only include emissions associated with the construction of domestic and non-domestic buildings and exclude emissions from infrastructure.

We then estimated the share of embodied emissions for buildings construction generated within the UK's borders (57 per cent), based on analysis published by WWF and the University of Leeds.[2] Under business as usual (but assuming improvements in grid intensity), the magnitude of construction embodied emissions in 2025 is expected to be comparable to the emissions level in 2013.[3] Therefore, the 2013 emissions levels estimated as described are taken as the baseline to analyse the overall emissions reduction potential possible through a more resource efficient approach.

Emissions reductions for 2025 are based on analysis by the Centre for Industrial Energy, Material and Products (CIEMAP), which has estimated emissions savings that could be achieved in the UK during the fourth carbon budget period (2023-27).[4]

Emission reduction levels associated with reducing input materials and increasing reuse are scaled to the share of embodied emissions associated with buildings construction vs total construction emissions (ie 79 per cent) to provide an estimate of savings for buildings only. In addition, we estimate that further ten per cent carbon savings can be achieved through better use of buildings, which reduces the need for new build.[5]

The table below summarises the data on embodied emissions and carbon savings:

		MtCO_2e / year
Embodied emissions 2013 (UK only, buildings only)		20.5
Annual savings during fourth carbon budget	Reduced material input	0.6
	Use of low carbon materials	4.0
	Increased buildings utilisation	2.1
	Increased reuse	1.5
Embodied emissions 2025 with resource efficiency measures (UK only, buildings only)		12.3

Comparison of carbon emissions for different retrofit options and new build

The operational and embodied emissions were estimated for a property of surface area of $76m^2$. For a lifespan of 60 years (from construction of new build, or from the retrofit intervention).

Data and sources are outlined in the table below:

Type of building	Type of intervention	Embodied carbon (tCO_2)	Operational carbon (tCO_2/year)	References and assumptions
Pre-1930s solid wall house	Without retrofit	-	3.93	Data from A Moncaster, 2013. 'Retrofitting solid wall buildings : carbon costs and savings', *International Sustainable Building Conference*, pp95–101. https://doi.org/10.3217/978-3-85125-299-6
	With minor retrofit	1.4	2.33	Data based on average embodied and operation carbon for minor retrofit, as estimated by A Moncaster, 2013, op cit
	With deep retrofit	21	0.59	Embodied carbon based on estimate for advanced retrofit options, as estimated in Camco, 2011, *Lifetime emissions of retrofit versus new build*. (Note that innovation in low carbon processes and materials could lead to lower embodied emissions in future.) Operational carbon based on 85 per cent savings compared to a property without retrofit, as estimated in Green Alliance, 2019, *Reinventing retrofit*.
New build (average values across the sector)	Current average	76	2.38	Embodied carbon for current average and 2020 target is based on Royal Institute of British Architects (RIBA), 2019, *RIBA 2030 Climate Challenge*. Operational carbon is based on values for annual operational energy per metre square (as set out in RIBA, 2019, op cit), converted to carbon emissions using SAP 10 emission factors and the assumption of 4:1 ratio of gas to electricity use. (Note that these values refer to sector averages and that best practice as well as innovation could deliver lower carbon levels.)
	RIBA Climate Challenge 2020 target	45.5	1.71	

Analysis of demand for new dwellings, vacant properties and demolitions

Assessment of demand for new homes is based on household projections for England, by region and local authority.[6] Total demand for new homes by 2030 was estimated from comparison between household numbers in 2020 and 2030.

Analysis of demolitions and long term vacant dwellings is based on data from the Ministry of Housing, Communities and Local Government (MHCLG).[7] The number of demolished dwellings was estimated assuming that annual demolitions are equal to the average number of annual demolitions based on the two most recent years (2017-18 and 2018-19).

The table below summarises the data on new households, vacant and demolished dwellings by 2030 for London and the Metropolitan Counties.

Area name	Demand for new households by 2030	Vacant dwellings	Demolitions by 2030	Vacant dwellings as a proportion of new household	Demolitions as proportion of new household
London	322,589	22,481	21,895	7%	7%
West Midlands	74,315	10,084	2,345	14%	3%
Greater Manchester	60,049	10,840	3,630	18%	6%
West Yorkshire	43,451	12,037	1,685	28%	4%
South Yorkshire	29,634	6,379	675	22%	2%
Merseyside	24,540	9,529	2,085	39%	8%
Tyne and Wear	14,826	6,763	3,510	46%	24%
Average				25%	8%

Overview of digital technology uptake

The table outlining the extent to which digital technology is being used across the lifecycle of buildings is based on analysis published by Cambridge Architectural Research.[8]

The category 'Single point and ongoing reality' included in our report is based on the combined results of 'on-going reality' and 'as-is reality' detailed in the original study. Furthermore, the five stages of a building's lifetime were grouped into three, based on the stages outlined in the framework on page five of our report.

Overall uptake for each category was determined by assigning a numerical value to each shaded cell in the original table (red, ie 'Technology limited but industry would like to use' = 1; yellow, ie 'Technology useful but has problem' = 2; green, ie 'Technology successfully implemented' = 3) and averaging the values across the relevant cells.

As the original study identified, no technology currently available for data-driven decision making applied to deconstruction, the respective cell is labelled as 'Technology absent' in our study. Expert consultations conducted as part of this project have suggested that this is an area where technology innovation would be desirable.

Endnotes

[1] Dr Jannik Giesekam, Centre for Research into Energy Demand Solutions (CREDS) at the University of Leeds
[2] WWF & University of Leeds, 2020, *Carbon footprint: exploring the UK's contribution to climate change*
[3] J Giesekam, J Barrett and P Taylor, 2018, 'Scenario analysis of embodied greenhouse gas emissions in UK construction', *Proceedings of the Institution of Civil Engineers–Engineering Sustainability*, 171, pp178–190
[4] Green Alliance, 2018, *Less in, more out*
[5] Based on Arup, C40 Cities and University of Leeds, 2019, *The future of urban consumption in a 1.5°C world*, p81; this is likely to be a conservative estimate of the potential carbon savings, given that our assessment of vacant dwellings that could be repurposes to meet demand for new homes (as outlined in this methodology) suggests a greater scale of opportunity.
[6] Office for National Statistics (ONS), 2018, '2016-based household projections for local authorities and higher administrative areas in England', table 406: household projections, mid-2001 to mid-2041.
[7] MHCLG, 2019, 'Statistical dataset. Live tables on housing supply: net additional dwellings', Table 123: Housing supply; net additional dwellings, component flows of, by local authority district, England, 2018-19; MHCLG, 2019, 'Statistical dataset. Live tables on dwelling stock (including vacants)', table 615: all long-term2 vacant dwellings by local authority district, England, from 2004.
[8] Cambridge Architectural Research Ltd, 2018, *Defining the research agenda and research landscape for Digital Built Britain: digital tools in the creation and through-life management of built assets*, figure 3-2: 'Map of current digital technology use'.