Nexus of construction waste management & carbon emissions

Cases from the UK student accommodation refurbishment projects

Dr Eric C.W. Lou

Reader in Project Management

Department of Engineering

Manchester Metropolitan University

e.lou@mmu.ac.uk

@EricLouMCR

http://uk.linkedin.com/in/ericlou/

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waste & carbon

- Setting the scene
- Carbon: *Emissions & Calculations*
- Waste: *Management & Calculations*
- Bringing it together

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climate change

Greenhouse gas (GHG) emissions from buildings will be a significant portion of the overall emission profile of any given country.

How buildings are constructed, materials used, energy consumed and building management and eventually demolished, ultimately determines the whole life cycle environmental footprint of any given building.

The UK built environment contributes around

40%

of total carbon footprint.

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student accommodation

The student accommodation sector in now the best-performing asset in the UK and US property markets and this is projected to further accelerate.

Building refurbishment of existing student accommodations being the preferred method to satisfy growing demand.

Student Accommodation Sector has grown by a net increase of

2.6%

in 2020 with more than

25,000

new beds coming to the UK market.

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environmental assessment systems

Schemes	Country	Year first published	Developer	Assessment scheme	References
Building Research Establishment Environmental Assessment Methodology (BREEAM)	UK	1990	Building Research Establishment	BREEAM UK Refurbishment and Fit-out 2014	BREEAM (2015a)
Leadership in Energy and Environmental Design (LEED)	USA	1998	US Green Building Council, CNU (Congress for the new urbanism), NRDC	New construction and major renovations (v4)	USGBC (2011)
Comprehensive Assessment System for Built Environment Efficiency (CASBEE)	Japan	2001	Japan Sustainable Building Consortium, Japan Green Building Council	CASBEE-renovation	CASBEE (2015)
Building Environmental Assessment Method (BEAM) Plus	Hong Kong	1996	Hong Kong Green Building Council	New Building Version 1.2	HKGBC (2012)
Green Building Labelling System (GBLS)	Taiwan	1999	Taiwan Architecture and Building Research Institute	GBLS: EEWH-renovation	GBL (2013)
Haute Qualité Environnementale (HQE)	France	1996	HQE Association	Environmental performance non-residential buildings	HQE (2013)
Green Star	Australia	2003	Green Building Council of Australia	Design and As Built	GBCA (2014)
Green Mark	Singapore	2005	Building and Construction Authority	Non-residential existing building	BCA (2012)
Green Building Index (GBI)	Malaysia	2010	Malaysian Institute of Architects and the Association of Consulting Engineers Malaysia	Non-residential existing building	GBI (2011)
Malaysian Carbon Reduction and Environmental Sustainability Tool (MyCrest)	Malaysia	2013	Public Work Department Malaysia and Construction Industry Development Board	New Construction	CIDB (2013)


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Review

Environmental assessment schemes for non-domestic building refurbishment in the Malaysian context

Syahrul Nizam Kamaruzzaman[a,*], Eric Choen Weng Lou[b], Nurshuhada Zainon[a], Noor Suzaini Mohamed Zaid[a], Phui Fung Wong[a]
[a] Faculty of Built Environment, University of Malaya, 50603 Kuala Lumpur, Malaysia
[b] School of Mechanical, Aerospace and Civil Engineering, University of Manchester, Manchester M13 9PL, United Kingdom

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ABSTRACT
The increase in global warming, energy consumption and greenhouse gas emissions has gained attention in various regions. In Malaysia, the government announced a voluntary commitment to reduce 40% of CO_2 emissions by 2020 and to refurbish 100 government buildings. Existing buildings make a large contribution to energy consumption and CO_2 emissions, therefore refurbishing existing buildings is an essential strategy to achieve the commitment. There is no single assessment scheme for building refurbishment in Malaysia and hence, this study aims to develop a comprehensive list of assessment themes and sub-themes for building refurbishment purposes. It examines and compares 10 assessment schemes from various countries: BREEAM, LEED, CASBEE, BEAM Plus, GBLS, Green Star, HQE, Green Mark, GBI and MyCrest. The findings revealed fourteen themes that were considered for assessment: *management, sustainable site, transport, indoor environmental quality (IEQ), water, waste, material, energy, pollution, innovation, economic, social, culture and quality of services*. Energy and IEQ are dominant themes in all assessment schemes. Most of the schemes are considered relatively weak in evaluating economic and social aspects, in comparison to environmental aspects. The assessment of quality of services is overlooked in most of the schemes, including GBI and MyCrest in Malaysia. Outcomes from this paper will form the baseline for a new environmental assessment scheme that aimed at non-domestic building refurbishments in Malaysia. A new model is proposed for the development of an environmental assessment scheme in the further stage.

Contents

* Corresponding author. Tel.: +60 3 7967 6833; fax: +60 3 7967 5713.
E-mail address: syahrulnizam@um.edu.my (S.N. Kamaruzzaman).

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environmental assessment systems

BREEAM Refurbishment and Fit-Out Technical Standard

Wst 01 Project waste management

Number of credits available	Minimum standards	Applicability			
6	Yes	Part 1	Part 2	Part 3	Part 4
		Yes	Yes	Yes	Yes

To promote resource efficiency via the effective management and reduction of refurbishment and fit-out waste and the reuse and direct recycling of materials.

https://www.breeam.com/discover/technical-standards/refurbishment-and-fit-out/

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environmental assessm

DESIGN REFERENCE GUIDE

Residential Building & Landed Home

Version 3.2

February 2021

RES 4-3 Waste Disposal (1)

RES 6-1 Carbon Emission (3)

Credit Allocation:

	Category	Credits Allocations	
(I)	Energy Related Requirements	High- Rise	Landed
Minimum 30 credits	**Part 1: Energy Efficiency**		
	RES 1-1 Thermal Performance of Building Envelope -RETV	15	22
	RES 1-2 Naturally Ventilated Design and Energy Efficient Cooling	22	22
	RES 1-3 Daylighting	6	6
	RES 1-4 Artificial Lighting	8	4
	RES 1-5 Ventilation in Carparks	6	2
	RES 1-6 Domestic Hot Water System	3	3
	RES 1-7 Lifts	1	1
	RES 1-8 Cool Hardscaped Areas	2	2
	RES 1-9 Energy Efficient Features	7	7
	RES 1-10 Renewable Energy	15	15
	Category Score for Part 1 – Energy Efficiency	**85 (Max)**	**84 (Max)**
(II)	**Other Green Requirements**		
Minimum 20 credits	**Part 2: Water Efficiency**		
	RES 2-1 Water Efficient Fittings	8	8
	RES 2-2 Water Usage Monitoring	1	1
	RES 2-3 Irrigation System and Landscaping	3	3
	Category Score for Part 2 – Water Efficiency	**12**	**12**
	Part 3: Environmental Protection		
	RES 3-1 Sustainable Construction	10	10
	RES 3-2 Sustainable Products	8	8
	RES 3-3 Greenery Provision	8	8
	RES 3-4 Environmental Management Practice	10	10
	RES 3-5 Green Transport	5	5
	RES 3-6 Stormwater Management	3	3
	RES 3-7 Internet Connectivity	1	1
	RES 3-8 Community Connectivity	1	1
	Category Score for Part 3 – Environmental Protection	**47**	**47**
	Part 4: Indoor Environmental Quality		
	RES 4-1 Noise Level	1	1
	RES 4-2 Indoor Air Pollutants	2	2
	RES 4-3 Waste Disposal	1	1
	RES 4-4 Indoor Air Quality in Wet Areas	2	2
	Category Score for Part 4 – Environmental Quality	**6**	**6**
	Part 5: Other Green Features		
	RES 5-1 Green Features & Innovations	7	7
	Category Score for Part 5 – Other Green Features	**7**	**7**
	Part 6: Carbon Emission of Development		
	RES 6-1 Carbon Emission of Development	3	3
	Category Score for Part 6 – Carbon Emission of Development	**3**	**3**
	GreenRE Score:	**160 (Max)**	**159 (Max)**

**Total score will be rounded to the nearest whole number*

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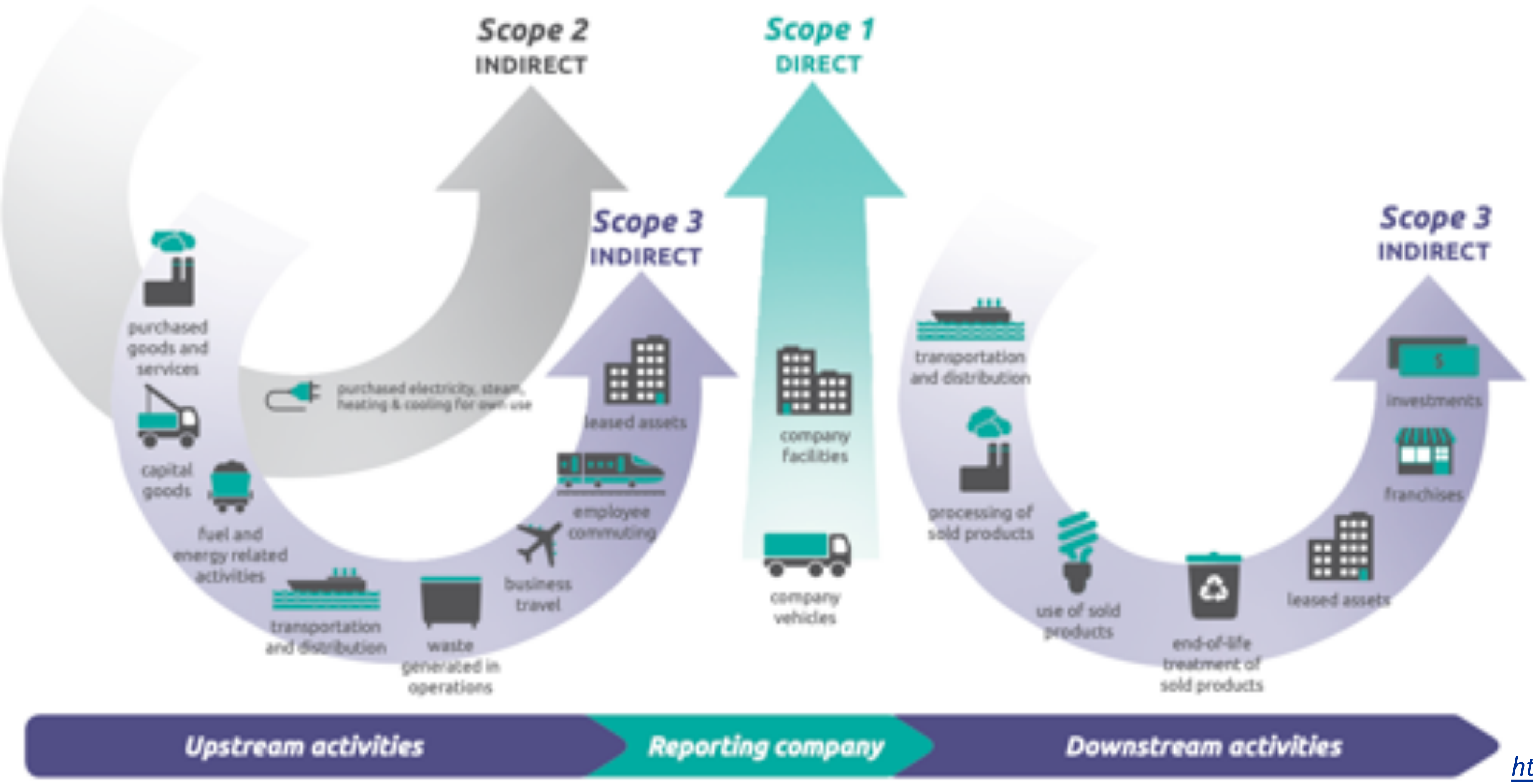
carbon calculation

GREENHOUSE GAS PROTOCOL



In 2016,

92%

of Fortune 500 companies used GHG Protocol directly or indirectly through a program based on GHG Protocol.

https://ghgprotocol.org/standards

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carbon calculation

GREENHOUSE GAS PROTOCOL

Calculator example

https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2020

Scope 1 Direct Emissions (Fuel used)

Business Travel				Site visit frequency												
Person	Type	Distance (return) (km)	Emmision factor (kgCO2e/unit)	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13
Managing Director	Car-petrol	168	0.2095	2	2	2	2	2	2	2	2	2	2	2	2	1
Operations Manager	Car-petrol	168	0.2095	3	10	10	11	13	10	12	11	12	13	14	13	5
Quantity Surveyor	Car-petrol	168	0.2095	3	12	13	10	12	9	10	12	11	13	12	10	0
Project Administrator	Car-diesel	168	0.1987	1	1	1	1	1	1	1	1	1	1	1	1	1
Enviornmental Manager	Car-diesel	80	0.1987	1	1	1	1	1	1	1	1	1	1	1	1	1
Site Manager	4x4 diesel	4	0.2635	15	21	22	23	22	17	23	20	21	22	23	20	10
Assitant Site Manager	Car-petrol	65	0.2095	6	3											
Assitant Site Manager	Car-petrol	50	0.2095		21	22	22	22	17	23	20	20	21	23	20	8
Labourer	Motorcycle	20	0.1067		21	21	23	22	17	23	18	21	22	22	20	9

Scope 2 (Indirect) (Purchased energy)

Stationary source		Usage quantity												
	Emmision factor (kgCO2e/unit)	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13
Electricity (kWh)	0.5452	474	764	809	829	912	1132	953	1021	982	972	921	871	542
Natural Gas (kWh)	0.1852													
LPG (kWh)	0.214													
Coal (kWh)	0.322													
Generator	2.322													

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carbon calcu

Calculator example

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→ Brexit | Check what you need to do

Home > Environment > Climate change and energy > Energy and climate change: eviden

Research and analysis

Greenhouse gas reporting: conversion factors 2020

The conversion factors are for use by UK and international organisations to report on 2020 greenhouse gas emissions.

https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2020

Scope 3 (Indirect) (Outsourced activities requiring fuel, energy, etc)

Business Travel

	Type	Distance [return] (km)	Emmision factor (kgCO2e/unit)	Site visit frequency												
				M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13
Client 1	Car-petrol	114	0.2095	1	1	1	1	1	1	1	1	1	1	1	1	1
Client 2	Car-petrol	114	0.2095	1	1	1	1	1	1	1	1	1	1	1	1	1
QS 1	Car-petrol	110	0.2095	1	1	1	1	1	1	1	1	1	1	1	1	1
QS 2	Car-petrol	110	0.2095	2	5	6	5	5	4	3	2	2	2	1	1	1
QS 3	Car-petrol	110	0.2095		1	1	1	1	1	1	1	1	1	1	1	1
CDM	Car-petrol	112	0.2095	1	1	1	1	1	1	1	1	1	1	1	1	1
H&S Consultant	Car-petrol	105	0.2095	1	1	1	1	1	1	1	1	1	1	1	1	1
H&S Consultant	Car-petrol	26	0.2095	1	1	1	1	1	1	1	1	1	1	1	1	1
Strip Out - flooring	VAN-petrol	110	0.2405	5	12	17	18	20	15	21	20	23	21	19	16	10
Mechanical	VAN-petrol	70	0.2405	10	21	22	21	24	21	24	21	24	22	18	15	7
Electrical	VAN-petrol	70	0.2405	10	21	29	26	26	20	25	19	24	21	22	16	10
Suspended Ceilings	VAN-petrol	145	0.2405	4	14	31	28	29	20	23	17	20	17	15	12	4
Hygienic Wall Cladding	VAN-petrol	55	0.2405	4	15	21	19	17	10	13	10	11	12	15	13	6
Floor Finishes	VAN-petrol	5	0.2405	5	21	29	28	29	21	24	19	17	16	18	15	8
Painting and Decorating	VAN-petrol	70	0.2405	5	21	28	27	28	21	28	22	25	21	23	18	10
FF&E	VAN-petrol	140	0.2405		21	29	27	27	19	21	17	19	20	19	15	8
Mastic Sealant	VAN-petrol	120	0.2405		10	18	17	16	10	14	12	13	14	16	14	6
Joinery	VAN-petrol	75	0.2405		15	19	18	20	11	17	15	19	17	15	12	7
Fire Alarm	VAN-petrol	140	0.2405		6	8	10	9	4	10	8	9	10	6	5	2
Cleaning	VAN-petrol	40	0.2405		12	17	10	10	6	11	9	10	8	9	7	3

Material Transport (deliveries, suppliers)

	Type	Distance [return] (km)	Emmision factor (kgCO2e/unit)	Site visit frequency												
				M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13
Cabins	HGV	130	0.8952	2												2
Consumables	LGV - diesel	40	0.588	1	2	5	6	6	4	6	5	5	7	6	5	2
Floor Finishes	LGV - diesel	70	0.588	6	11	16	18	17	10	11	11	13	13	10	9	5

Project Vehicles

	Type	Distance [return] (km)	Emmision factor (kgCO2e/unit)	Site visit frequency												
				M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13
Skips	LGV - petrol	50	0.5637	4	10							3	4	3	3	3
Skips	LGV - petrol	70	0.5637			4	2	2	2	2	3				3	3
Recycling	HGV	100	0.8952			2				1						

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carbon calculation

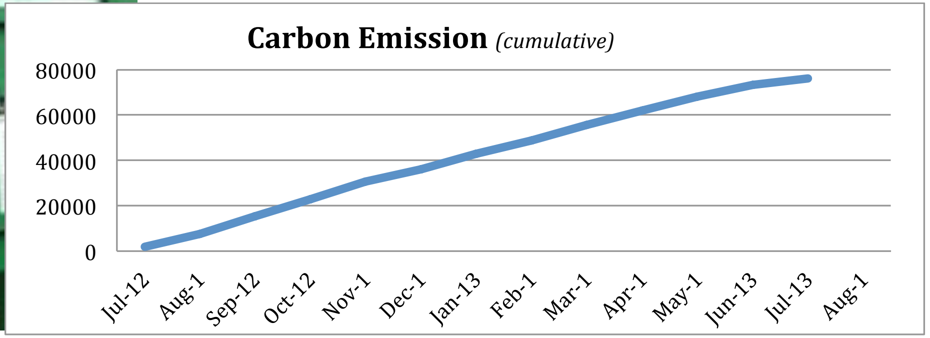
GREENHOUSE GAS PROTOCOL

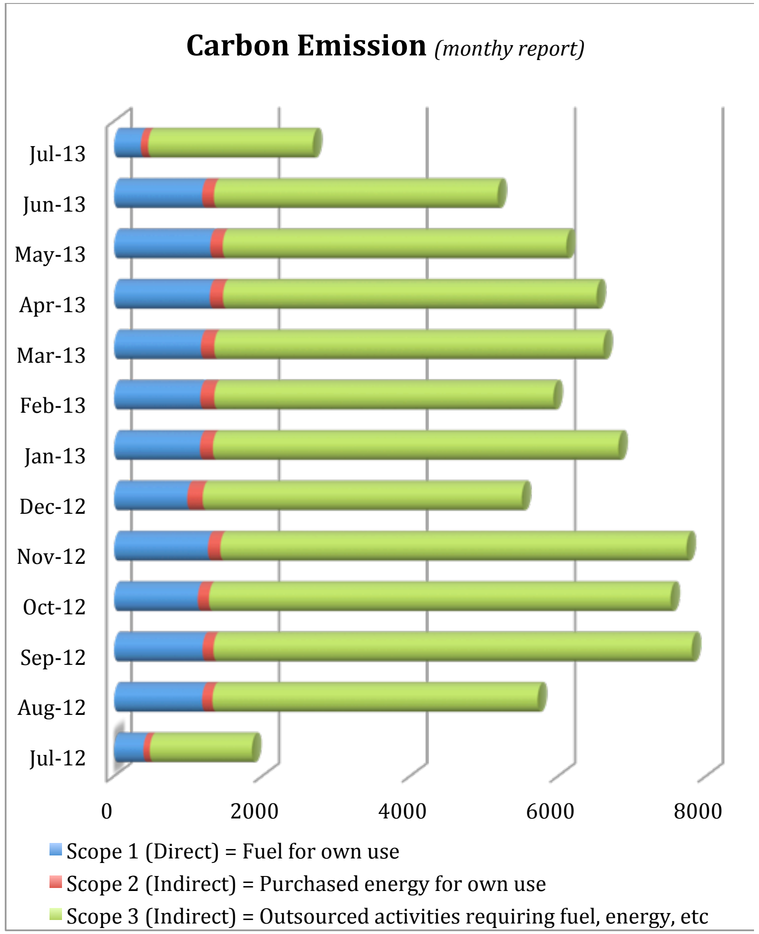
Report & Display example

CARBON EMISSION REPORT (JULY 2013 *[final]*)

Atlantic Point Carbon footprint : **76,021** $kgCO_2e$

		Scope 1	Scope 2	Scope 3
Estimated emission		41,853	12,431	162,805
Emission reduction target		33,482	11,188	113,964
Actual emission		**13,794**	**2,071**	**60,156**
Report by month	Jul-13	359.92	100.38	2223.88
	Jun-13	1188.36	161.31	3831.66
	May-13	1297.60	170.57	4643.81
	Apr-13	1291.50	180.01	5048.90
	Mar-13	1172.24	181.87	5257.43
	Feb-13	1164.79	189.09	4583.48
	Jan-13	1158.95	176.50	5456.30
	Dec-12	987.28	209.65	4307.56
	Nov-12	1266.77	168.902	6300.60
	Oct-12	1129.18	153.531	6238.34
	Sep-12	1194.25	149.83	6466.64
	Aug-12	1188.38	141.49	4393.60
	Jul-12	394.98	87.75	1379.40





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Case study project estimated GHG emission data.

Project	GHG Emission Scope	Organisational KPI Data									
		Distance ($kgCO_2^{eq}$ per km)		Duration ($kgCO_2^{eq}$ per week)		GIFA ($kgCO_2^{eq}$ per m^2)		Rooms ($kgCO_2^{eq}$ per room)		Value ($kgCO_2^{eq}$ per £100k)	
		WLC	RP	WLC	RP	WLC	RP	WLC	RP	WLC	RP
CS-1	Scope 1	133.0	111.6	249.6	209.6	0.8	0.7	37.8	31.7	2.6	2.2
	Scope 2	59.3	46.9	111.3	88.1	0.4	0.3	16.8	13.3	1.1	0.9
	Scope 3	639.4	483.7	1200.5	908.1	3.8	2.8	181.6	137.3	12.3	9.3
	Overall	*831.6*	*642.2*	*1561.5*	*1205.8*	*4.9*	*3.8*	*236.1*	*182.4*	*16.0*	*12.4*
CS-2	Scope 1	82.1	77.6	242.0	228.8	0.8	0.7	27.9	26.3	3.4	3.2
	Scope 2	12.3	11.2	36.3	33.0	0.1	0.1	4.2	3.8	0.5	0.5
	Scope 3	358.1	336.6	1055.4	992.2	3.4	3.2	121.5	114.3	14.7	13.8
	Overall	*452.5*	*425.5*	*1333.7*	*1254.0*	*4.3*	*4.0*	*153.6*	*144.4*	*18.5*	*17.4*
CS-3	Scope 1	16.3	12.1	431.3	318.8	0.9	0.6	20.5	15.2	3.7	2.8
	Scope 2	1.1	0.8	28.2	20.8	0.1	0.0	1.3	1.0	0.2	0.2
	Scope 3	78.2	56.5	2063.8	1492.6	4.1	2.9	98.3	71.1	17.8	12.9
	Overall	*95.6*	*69.4*	*2523.3*	*1832.1*	*5.0*	*3.6*	*120.2*	*87.2*	*21.8*	*15.8*
CS-4	Scope 1	52.1	39.3	1529.6	1151.6	2.4	1.8	53.4	40.2	11.8	8.9
	Scope 2	1.3	1.0	38.5	29.7	0.1	0.1	1.3	1.0	0.3	0.2
	Scope 3	53.3	41.5	1562.3	1216.7	2.4	1.9	54.5	42.4	12.0	9.4
	Overall	*106.7*	*81.8*	*3130.4*	*2397.9*	*4.8*	*3.7*	*109.2*	*83.7*	*24.1*	*18.5*

WLC: Estimated emissions reflecting the whole lifecycle of the case study projects ($kgCO_2^{eq}$).
RP: Estimated emissions reflecting the refurbishment phase of the case study project's lifecycles (excluding project start-up and move-out) case study projects GHG levels emissions analysis ($kgCO_2^{eq}$).

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carbon calculation

GREENHOUSE GAS PROTOCOL

Positive corelation in GHG performance and its duration, value, gross internal floor area (GIFA) and number of rooms.

Project GIFA was identified as the KPI that provided the most consistent and accurate prediction of the GHG performance of student accommodation refurbishment projects using JCT Design and Build contracts in the UK.


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ELSEVIER

Greenhouse gases (GHG) performance of refurbishment projects – Lessons from UK higher education student accommodation case studies

Eric C.W. Lou, Ph.D [a,*], Angela Lee, PhD [b], Andrew Welfle, Ph.D [c]

[a] School of Mechanical, Aerospace & Civil Engineering, University of Manchester, Pariser Building, Sackville Street, Manchester, M13 9PL, UK
[b] School of Art, Design and Architecture, University of Huddersfield, Queensgate, Huddersfield, HD1 3DH, UK
[c] Tyndall Centre for Climate Change Research, School of Mechanical Aerospace & Civil Engineering, University of Manchester, Pariser Building, Sackville Street, Manchester, M13 9PL, UK

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ABSTRACT

The student accommodation sector in now the best-performing asset in the UK and US property markets and this is projected to further accelerate, with building refurbishment of existing student accommodations being the preferred method to satisfy growing demand. However, there are no published research studies on refurbishment projects within the student accommodation sector. Refurbishment is an emergent trend to upgrade existing stock to ensure that buildings meet rising energy efficiency demands. Moreover, it is widely affirmed that greenhouse gases contribute to climate change and notably the built environment is a significant contributor, both through its construction and during its operation and use. This paper demonstrates through a comparative case study approach, how greenhouse gases levels can be effectively measured during refurbishment works. There are multiple metrics used for quantification/assessment of greenhouse gases performance and this paper aims to make well-argued recommendations for their best use. Four student accommodation refurbishment projects are presented to compare and contrast differing emission datasets. The results dictate that project cost and duration cannot alone be used to gauge greenhouse gases emissions; more too, in the instance of student accommodation refurbishment, gross internal floor area and the number of rooms offers a more predictable indicator. It is recommended that refurbishment developers reflect on these recommendations when reporting the primary energy and GHG performance of their refurbishment works. Best practice from this research may be adopted into domestic buildings refurbishment projects.

1. Introduction

There is growing scientific and political consensus that climate change represents the greatest environmental threat and challenge of modern times. The key driver of climate change is the robust link between the generation of greenhouse gases (GHG) and rising global temperatures (CCC, 2016). GHG emissions from UK buildings have been reported to contribute up to 37% of the UK's total GHG emissions (TSB, 2014). Notwithstanding GHG emissions generated during the design, material manufacture, distribution and on-site construction of both the UK buildings - reflecting up to 18% of a building's whole lifecycle carbon footprint (BIS, 2010). A clear link has been identified between the whole lifecycle environmental and GHG performance of a building and the focus and investment during the construction phase. For example lower levels of initial capital investment spent on insulation or plant may result in increased operation or maintenance expenditure and reduced environmental performance over the buildings whole lifecycle (Bribián et al., 2009). Therefore if the UK is to meet its climate change targets whilst maintaining a vibrant construction sector, the industry needs to also reduce the impact of buildings through improved construction practices.

The UK Department for Environment, Food and Rural Affairs (DEFRA) confirms that improvements driven by construction industry players will be crucial for reducing emissions (DEFRA, 2013). Considering that 87% of existing buildings in the UK will likely be

* Corresponding author.
E-mail addresses: eric.lou@manchester.ac.uk (E.C.W. Lou), a.lee@hud.ac.uk (A. Lee), andrew.welfle@manchester.ac.uk (A. Welfle).

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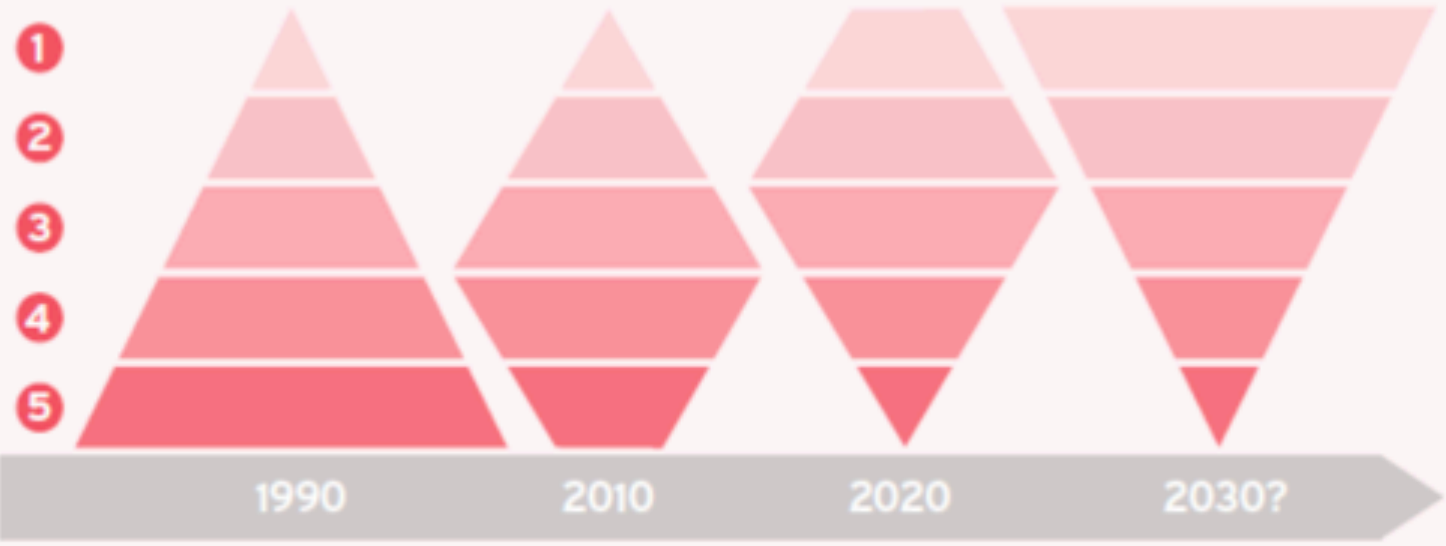
waste

https://www.constructionleadershipcouncil.co.uk/news/zero-avoidable-waste-report-published-by-the-green-construction-board/

Evolution of Waste Management Practices: In the past, most waste was dealt with by disposal, but over time that will shift increasingly to recycling, reuse and ultimately prevention.



1 Prevention
Using less material in design and manufacture. Keeping products for longer; reuse. Using less hazardous materials.

2 Preparing for reuse
Checking, cleaning, repairing, refurbishing, whole items or spare parts.

3 Recycling
Turning waste into a new substance or product. Includes composting if it meets quality protocols.

4 Other recovery
Includes anaerobic digestion, incineration with energy recovery, gasification and pyrolysis which produce energy (fuels, heat and power) and materials from waste; some backfilling.

5 Disposal
Landfill and incineration without energy recovery.

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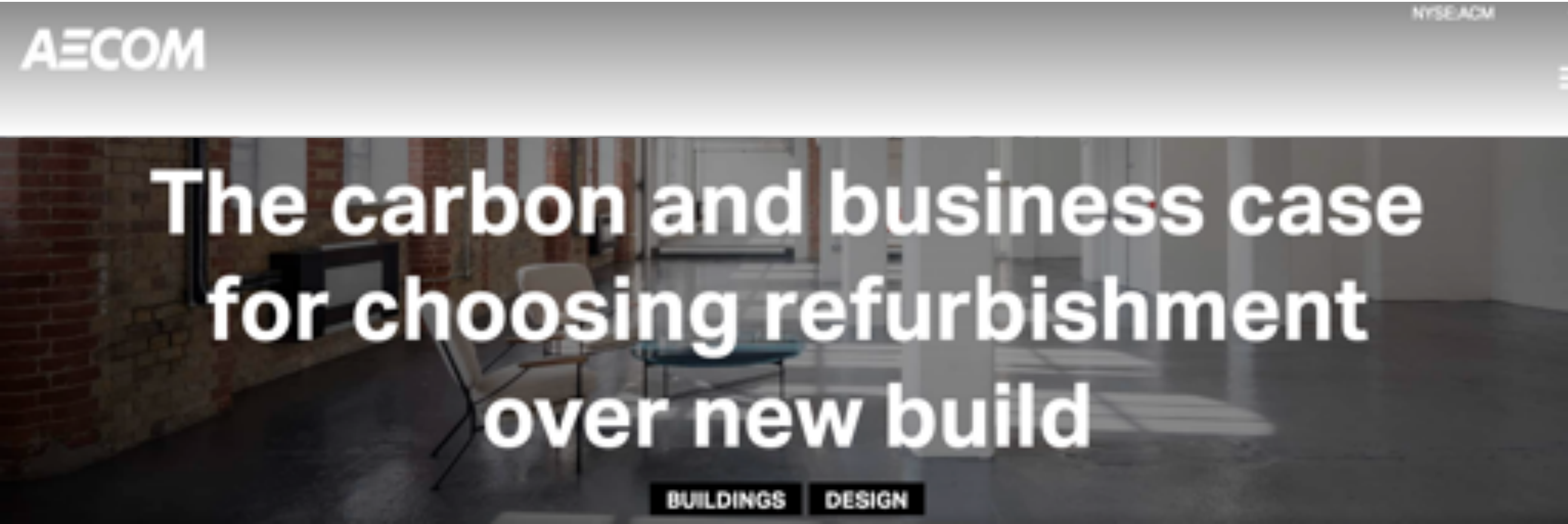
waste

New build *vs* Refurbishment

https://aecom.com/without-limits/article/refurbishment-vs-new-build-the-carbon-and-business-case



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waste

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waste

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waste calculation

Comparing waste management performance against industry benchmarks for standard, good and best Practice.

Waste Resource	Diversion of Waste from Landfill (%)					
	Case Study Project A	Case Study Project B	Case Study Project C	Standard Practice	Good Practice	Best Practice
	Project Data	Project Data	Project Data	(WRAP, 2007)	(WRAP, 2007)	(WRAP, 2007)
Bricks	0.84	1	-	0.75	0.85	1
Tiles & Ceramics	0.77	-	0.00	0.75	0.85	1
Glass	-	-	0.00	0.75	0.95	1
Aggregates/Hardcore/Inert	0.82	1	0.00	0.75	0.85	1
Insulation/Fabrics	0.00	-	0.00	0.12	0.5	0.75
Metal	0.84	1	0.00	0.95	1	1
Packaging	0.83	1	0.00	0.6	0.85	0.95
Gypsum/Plasterboard	-	1	0.00	0.3	0.9	0.95
Plastic	0.65	1	0.00	0.6	0.8	0.95
Timber	0.76	1	0.00	0.57	0.9	0.95
Floor Coverings (soft)	0.38	-	-	0.12	0.5	0.75
Electrical & Electronic Equipment	-	1	0.00	0.5	0.7	0.95
Furniture	1	1	0.00	0.1	0.25	0.5
Canteen/Office/Adhoc Waste	-	-	0.78	0.12	0.5	0.75
Other	0.72	0.58	0.00	0.12	0.5	0.75

Red	Proportion of waste diverted to landfill below the WRAP levels for 'standard practice'.
Blue	Proportion of waste diverted to landfill achieving WRAP levels for 'standard practice'.
Orange	Proportion of waste diverted to landfill achieving WRAP levels for 'good practice'.
Green	Proportion of waste diverted to landfill achieving WRAP levels for 'best practice'.

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waste calculation

Waste Resource	Case Study Project A					Case Study Project B					Case Study Project C				
	Waste (t)	Waste Management Strategy				Waste (t)	Waste Management Strategy				Waste (t)	Waste Management Strategy			
		RU	RC	RR	D		RU	RC	RR	D		RU	RC	RR	D
Bricks	1.2	–	0.84	–	0.16	3.3	–	1.0	–	–	–	–	–	–	–
Tiles & Ceramics	1.9	–	0.77	–	0.23	–	–	–	–	–	2.9	–	–	–	1.0
Glass	–	–	–	–	–	–	–	–	–	–	0.3	–	–	–	1.0
Aggregates/Hardcore/Inert	21.4	–	0.82	–	0.18	1.8	–	1.0	–	–	49.6	–	–	–	1.0
Insulation/Fabrics	7.3	–	–	–	1.0		–	–	–	–	0.4	–	–	–	–
Metal	1.7	–	0.84	–	0.16	0.9	–	1.0	–	–	6.1	–	–	–	1.0
Packaging	34.1	–	0.83	–	0.17	0.9	–	1.0	–	–	0.8	–	–	–	1.0
Gypsum/Plasterboard	–	–		–		0.5	–	1.0	–	–	2.3	–	–	–	1.0
Plastic	9.9	–	0.65	–	0.35	1.0	–	1.0	–	–	1.1	–	–	–	1.0
Timber	26.4	–	0.76	–	0.24	0.01	–	1.0	–	–	11.0	–	–	–	1.0
Floor Coverings (soft)	51.7	–	0.38	–	0.62	–	–	–	–	–	–	–	–	–	–
Electrical & Electronic Equipment	–	–	–	–	–	2.0	–	1.0	–	–	5.0	–	–	–	1.0
Furniture	61.5	0.41	0.59	–	–	19.0	0.47	0.53	–	–	40.0	–	–	–	1.0
Canteen/Office/Adhoc Waste	–	–	–	–	–	–	–	–	–	–	2.9	–	0.78	–	0.22
Other	41.6	–	0.72	–	0.28	0.8	–	0.58	–	0.42	2.3	–	–	–	1.0
Total Waste (t)	258.6	25.9	160.3	–	72.4	30.1	9.0	11.1	–	0.3	124.8	–	2.5	–	122.3

Waste - Total waste (t) generated by project.
RU - Proportion (%) waste reused.
RC - Proportion (%) waste recycled.
RR - Proportion (%) waste recovered.
D - Proportion (%) waste disposed through a landfill waste management strategy.

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waste calculation

There is a **disconnect between waste targets, legislation and sustainability benchmarking schemes** that measure success based on the levels of diverting waste from landfill, and the emission performance of waste management strategies.

Differentiation in waste management of **reuse, recover and recycle**, which involves a wide degree of effort in reusing existing items, recover as supplementary materials or segregated for recycling.

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Testing the Nexus between C&D waste management strategies & GHG emission performances: The case of UK student accommodation refurbishment projects

Eric C.W. Lou [a,*], Angela Lee [b], Andrew J. Welfle [c], Aminu L. Abdullahi [d]

[a] Department of Engineering, John Dalton Building, Manchester Metropolitan University, UK
[b] School of Science, Engineering & Environment, Maxwell Building, University of Salford, UK
[c] Tyndall Centre for Climate Change Research, Pariser Building, Department of Mechanical, Aerospace and Civil Engineering, University of Manchester, UK
[d] Kano University of Science and Technology, Wudil, Nigeria

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ABSTRACT

All governments, industry sectors and societies each have a pivotal role to play if we are to mitigate anthropogenic climate change. For the construction industry, limiting emissions and addressing issues of sustainability is not just important for reducing the environmental impacts of the sector, but is simply good practice. This research investigates the nexus between the generation and management of waste and greenhouse gas performance in the refurbishment sector, with specific focus on UK student accommodation projects. Performance data from three case study projects were analysed in order to: evaluate the types and extent of wastes and how they are managed; the greenhouse gas impacts of each project waste management strategy; and an assessment is undertaken to estimate the number of BREEAM waste credits that each project would have achieved. The research concludes that the overall greenhouse gas performance of a project's waste management strategy is highly dependent on how specific high emission impact factor waste streams are managed, and notably, there is a disconnect between waste targets, legislation and sustainability benchmarking schemes that measure success based on the levels of diverting waste from landfill, and the emission performance of waste management strategies. A key area of risk potentially overlooked relates to the scenarios where proportionally small quantities of high emission wastes (e.g. plastics) were sent to landfill alongside large quantities of low emission wastes (e.g. aggregates, bricks, etc.). To ensure the increased emission performance of the refurbishment sector, greater focus is needed on preventing specific categories of waste from the landfill pathway.

1. Introduction

Scientific and political pressure has ensured climate change remains a key theme on the World agenda. International actions such as the Kyoto Protocol [1] and the more recent Paris Agreement [2], demonstrate the prominence of the climate change issue, and highlight the types and scales of action that will be required to limit increases in global temperature. For the construction industry (CI), limiting emissions and addressing issues of sustainability is not just important for reducing the environmental impacts of the sector, but is simply good practice [3]. Greenhouse gas (GHG) emissions from buildings will be a significant portion of the overall emission profile of any given country, for example the built environment contributes around 40% of the UK's total carbon footprint [4].

How buildings are constructed, materials used, energy consumed and building management and eventually demolished, ultimately determines the whole life cycle environmental footprint of any given building [5]. The choice of construction materials is highly significant as the embodied energy required to make or create different materials can vary highly, in addition to the available methods for managing the materials post-use. Kilbert [6] reported that 90% of all materials ever extracted may be residing in the CI, and many of these materials during a building's demolition are ultimately regarded as waste [7]. To reduce the impact of these 'waste' materials from refurbishment activities, legislation has been developed to both reduce the levels of waste generated and to ensure that different categories of waste are managed using 'waste management strategies' that to reduce environmental impact. For example, The European Commission [8] Waste Framework

* Corresponding author. Department of Engineering, E308 John Dalton Building, Chester Street, Manchester Metropolitan University, UK.
E-mail address: e.lou@mmu.ac.uk (E.C.W. Lou).

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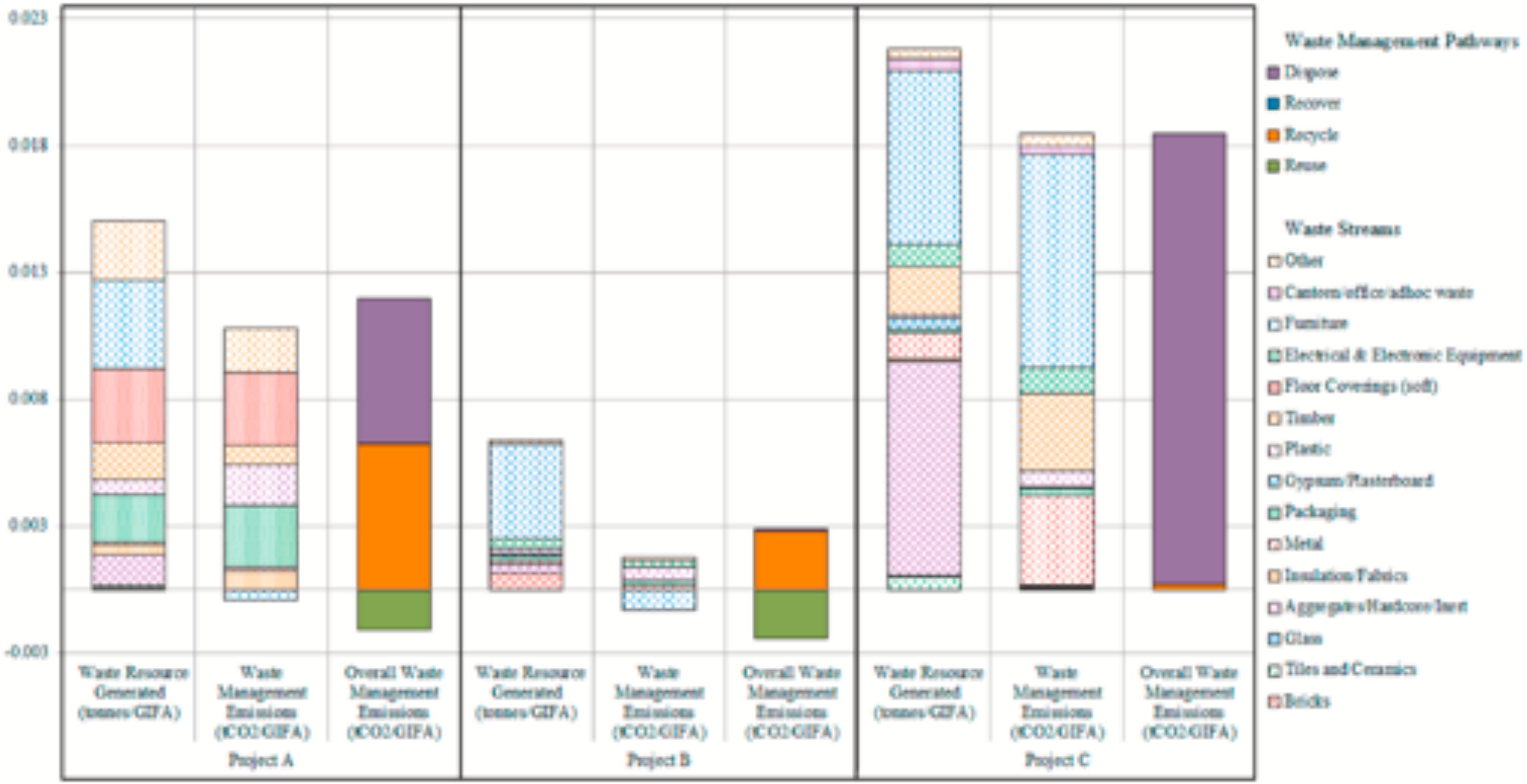
nexus of waste & carbon



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Calculated project performance for BREEAM credit Wst 01 – project waste management.

Generation of Waste							
BREEAM Credits	Required Performance *	Project Performance					
		Case Study A	Case Study B	Case Study C	Case Study A	Case Study B	Case Study C
	Total Waste Generated (t/100m² GIFA)				*Potential BREEAM Credits Achieved*		
1	≤3.5	1.45	0.59	2.13	1	2	1
2	≤1.2						
3	≤0.4						
4	≤0.3						
Diversion of Waste from Landfill							
BREEAM Credits	Required Performance **	Project Performance					
		Case Study A	Case Study B	Case Study C	Case Study A	Case Study B	Case Study C
	Proportion of Waste Diverted from Landfill (%)				*Potential BREEAM Credits Achieved*		
1	90%	28%	1%	98%	0	2	0
2	97%						

nexus of waste & carbon

- Criteria of BREEAM credits **does not guarantee** a low emission waste management strategy

- Diverting **high emission risk waste** to landfill *(such as plastics)* may offset any benefits gained through reusing and recycling other categories of waste *(such as furniture)*

what’s next ?

Moving towards more **digitalisation and simulation** before moving towards site activities (Industry 4.0)

Construction 4.0 Strategic Plan (2021-2025)

https://www.cidb.gov.my/en/construction-info/technology/ir40-construction

Industry 4.0 Facts and Figures

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Industry 4.0 could add **$14.2 trillion** to the global economy **by 2030**

35% of companies adopting Industry 4.0 expect revenue gains in the **next five years**

67% **of UK manufacturers** recognise Industry 4.0 as **an opportunity**

The **Made Smarter Review** estimates that the UK industry could achieve **25% increase in productivity** through digital adoption by **2025**

Only 25% of manufacturers feel that they have a **sufficient understanding** of Industry 4.0

$28 billion

The amount of expected **cost reduction** in the automotive sector between 2016 and 2020 due to Industry 4.0

30% increase in productivity could be achieved by the first wave of Internet of Things adopters

3.6%

average cost reduction by 2020

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thank you for your time

Dr Eric C.W. Lou

Reader in Project Management

Department of Engineering | Manchester Metropolitan University

e.lou@mmu.ac.uk

@EricLouMCR http://uk.linkedin.com/in/ericlou/

Manchester Metropolitan University

Dr Eric Lou

Reader in Project Management

Department of Engineering

e.lou@mmu.ac.uk

https://www2.mmu.ac.uk/engineering/staff/profile/index.php?id=3673

http://uk.linkedin.com/in/ericlou/

https://www.facebook.com/ericlou.profl

https://twitter.com/EricLouMCR

https://www.instagram.com/ericloucw/