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Towards a universal carbon footprint standard: A case study of carbon management at universities

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ABSTRACT

Organisations of all types are significant contributors to international greenhouse gas emissions. The business case for supporting low-carbon practices is gathering pace, alongside the regulatory demands imposed through carbon emission compliance reporting. Despite this, guidance for generating carbon footprints through hybrid environmentally extended input-output analysis is under-developed and under-researched. Higher Education Institutions are key components of education systems across the globe, transcending international borders, socio-political regimes and economic systems. As an internationally significant sector beginning to address climate issues through carbon reduction policies on and off the estate, very few research articles have been published that document emissions arising from all directly and indirectly attributable activities. This study outlines a number of key elements to standardise the organisational carbon footprinting process by reconciling and evaluating the methodological steps in six selected internationally reputable guidelines (published by the Global Reporting Initiative, the Carbon Disclosure Project, the United Kingdom's Government Department for Environment, Food and Rural Affairs, the Greenhouse Gas Protocol, the International Standardisation Organisation and the Higher Education Funding Council for England). A systematic review is undertaken which relates the four principles of carbon footprinting (boundary-setting, identification of activities, collecting of data and reporting/verification) to the academic literature. Then, via consultation with university environment managers, a number of recommendations are made to address and improve i) the potential to avoid double-counting, ii) the financial and resource cost of carbon footprinting and iii) the reliability and comparability of data compiled by institutions. We introduce a methodology for a universal, standardised footprinting standard for higher education (that could also apply to all organisations regardless of sector or region) with cut-off criteria that excludes paid-for products and services typically included in the 'Scope 3' proportion of the footprint. In proposing this methodology, carbon footprinting is made more applicable to higher education institutions (since existing standards are designed for generality and for profit-driven organisations) and the practical issues, associated with externally owned data and non-expert staff, are broadly overcome.

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1. Introduction

1.1. Organisational carbon footprinting

There is a global research agenda towards identifying sources and sinks of greenhouse gas (GHG) emissions across a breadth of scales. Many examples have emerged that aim to understand emission profiles; for products (i.e. Publically Available Specification (PAS) 2050/GHG protocol product life cycle standard), individuals, urban areas (e.g. PAS 2070) and entire nations (i.e. Intergovernmental Panel on Climate Change (IPCC) national GHG inventory), which differ by the sources of emissions encompassed in them. A product carbon footprint typically measures life-cycle emissions (from cradle-to-grave). An individual carbon footprint normally measures consumed goods and activity-related GHGs. National inventories generally measure emissions associated with the consumption of goods & energy and the imports & exports of

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goods and services at a country-wide scale (Gao et al., 2013).

Guidance for generating organisational carbon footprints is less developed than that for other forms (Pelletier et al., 2013). Nevertheless, the need for addressing this issue is pressing; organisations of all types are significant contributors to global GHG emissions. In 2013, direct emissions from the 500 largest companies in the world amounted to 3.6 Gigatonnes CO_2e (The Carbon Disclosure Project, 2014); 7% of total releases from anthropogenic sources (at 49 ± 4.5 $GtCO_2e$ (IPCC, 2014)). Differing standards of environmental regulation (as well as living standards and wage expectations), combined with pervasive rates of consumerism has caused a shift Eastwards of manufacturing industries now deemed too ‘dirty’ to exist in the West (Shapiro, 2012). Pollution at the price of convenience inhibits the global shift towards a low-carbon economy (Stearns, 2006).

In Europe, organisations have been governed by environmental legislation for some decades and some notable examples have changed the outlook of business to become more carbon-accountable (e.g. the European Union emissions trading scheme [EU ETS]). The United Kingdom's (UK) Climate Change Act 2008[1] was instrumental to the adoption of mandatory carbon reporting for all UK companies in 2013 and was the first dedicated piece of carbon-related legislation in the world. The combination of ‘hard’ approaches such as these, with ‘soft’ approaches (for example, through activities set out in corporate social responsibility (CSR) policies) encourages this shifting paradigm (Barth et al., 2013). As a consequence, organisations are increasingly measuring success on a triple bottom line (Norman and MacDonald, 2004).

Assigning and accounting for the entire range of emissions attributable to an organisation's activities is complex and difficult (Bastianoni et al., 2004; Department for Environment Food and Rural Affairs, 2009). Whilst Scope 1 (direct emissions from sources owned or controlled by the reporting organisation) and Scope 2 (from purchased electricity) are the simplest to assign and calculate, Scope 3 emissions (the remaining indirect emissions from purchased and sold goods and services) are seldom quantified in their entirety (Ranganathan et al., 2004; Huang et al., 2009). Guidance has often favoured the emission sources for which data is readily available. Despite a compelling case for quantifying Scope 3 emissions, up to 80% of a carbon footprint can be attributed to unreported indirect emissions (Ozawa-Meida et al., 2011). This issue is compounded by the complex nature of activities performed by organisations and the varying scales in which they operate (Williams et al., 2012a,b).

To mitigate the uncertainties and practical issues experienced by practitioners, environmental standards are developed. These interpret highly theoretical peer-reviewed literature into readily accessible technical notes (Auger, 1994). The number and variety of competing methodologies has the potential to introduce an unacceptable degree of discrepancy; organisations operating under one system are incomparable and may perform better than those favouring a different system (Kenny and Gray, 2009). Examples of this occur frequently and is not limited to organisational carbon footprinting; Dias and Arroja (2012) outline the differences in estimations for office paper between ISO14040, PAS 2050 and Confederation of European Paper Industries (CEPI) frameworks at 4.64 g, 4.74 g and 4.29 g CO_2e per A4 sheet respectively, whilst Turner et al. (2015) cite the methodological considerations made in calculating emission factors for waste materials as a predominant source of discrepancy.

Ensuring data are collected using analogous methodologies means that footprints are comparable (Rypdal and Winiwarter, 2001), reliable (Dragomir, 2012) (referring as much to the conclusions that can be drawn as the potency of the procedures in place to collect information) and robust (Kasah, 2013). Despite challenges, the business sector is beginning to capitalise on the low carbon economy emerging as carbon management tools and methods improve (Chakraborty and Roy, 2013) (in regards to their access/ubiquity, their value to consumers and their overall accuracy). The use of carbon footprinting tools has more importantly allowed organisations to: i) ‘hotspot’ areas of highly emitting activities (Minx et al., 2009); ii) streamline their supply chains (Sundarakani et al., 2010); and, iii) develop legitimate low-carbon products (Scipioni et al., 2012).

1.2. The higher education sector

Globally, the higher education (HE) sector exceeds 207 million people (United Nations Educational Scientific and Cultural Organization, 2014a) (around 34% of the global university-age demographic [United Nations Educational Scientific and Cultural Organization, 2014b]) and continues to undergo unprecedented change. There are estimated to be ca. 17,000 Higher Education Institutions (HEIs) worldwide, distributed among most nations, on every continent (except Antarctica) (Altbach et al., 2009). The number of students attending university since the year 2000 has grown exponentially; a trend likely to continue under most business-as-usual (BAU) scenarios, which estimate a rise to 262 million by 2025 (Goddard, 2011). Although in developed nations efforts have been made to enact moves towards low-carbon HE systems (Roy et al., 2008), the divide between less economically developed countries (LEDCs) and more economically developed countries (MEDCs) remains considerable (Drori et al., 2014).

In the United Kingdom (UK), the HE sector is extremely significant in terms of population, economic contribution and societal influence and therefore represents an important sector for long-term carbon management. With more than 318,000 staff and 1.7 million students in 160 institutions, the total economic value per annum equals £39.9 billion (Universities UK, 2015). As a result, HE is one of *the* largest occupiers of building space, occupying 27 million m^2 and is responsible for some 10,600 ha of land (HESA, 2014). It is well documented that HEIs are influential players in both local and national policymaking, both informing society through research and educating graduates (Etzkowitz, 1998). In addition, they are also successful incubators for innovation, from which many sustainability initiatives have originated (i.e. Blackout (University of Southampton (2012)), Student Switch off (Jones, 2012)).

It is widely recognised by university vice chancellors that prioritising carbon reductions not only yields environmental benefits but also promotes financial savings and increases competition (Epstein and Roy, 2003; Dangelico and Pujari, 2010). Sustainability reporting has been proven to help deliver these benefits (Lozano and Huisingh, 2011) as well as assist university leaders in directing on-campus operations and sustainability projects (Townsend and Barrett, 2015). The benefits manifest in substantial utility cost reductions (due to their size and scale) and an improved international reputation (Barber et al., 2013). Universities are now also finding that by incorporating sustainability education into the curriculum, they can add value to the quality of education students receive, as well as fostering cultural change within the organisation (Lozano, 2006; Savageau, 2013). This is important because the future challenge lies in reducing campus emissions whilst simultaneously expanding student numbers, extending their range of activities and remaining commercially competitive (Cronin et al.,

[1] The UK Climate Change Act 2008 legislated the UK towards an ambitious 80% reduction in direct (Scope 1 and 2) emissions below a 1990 baseline by 2050.

[2] Operational data is defined by the author as data that is directly transposable into the organisation's carbon footprint without much required processing.

2010). The recruitment rate of students has increased dramatically in the last 25 years, despite a turbulent period of UK government policy (i.e. the opening up of HE places preceding 1990, the expansion of the number of institutions in 1993, the introduction of tuition fees in 1998 and subsequent rise in 2004) and more institutions are understanding that students want to engage on such issues. The removal of the tuition fee cap in 2010 at the recommendation of Lord Browne did little to dent this trend (Wyness, 2010). The year 2015 saw a record number of students recruited at 532,000, a 3.1% increase on the previous year (Universities and Colleges Admissions Service, 2015).

1.3. A universal carbon footprint methodology for higher education

The Higher Education Funding Council for England (HEFCE) published a number of guides in 2012 with the aim of assisting institutions to report and reduce emissions. These focussed primarily on direct emissions (institutions have mandatory targets to reduce their Scope 1 and 2 emissions by 34% below a 2005/06 baseline by 2020) or on a limited number of Scope 3 sources (i.e. water and waste (HEFCE, 2010), transport (HEFCE, 2012b) and procurement [Arup et al., 2012]). Although no specific international standard for HE carbon footprinting exists, it is common for practitioners to adapt methodologies from those designed predominantly for profit-making enterprises. This is often conducted with limited success alongside the unrestricted use of assumptions and caveats to complicate their interpretation (Almeida et al., 2014). The hybridisation of input-output analysis and life cycle assessment theories (EEIOA-LCA) (Peters, 2010) are favoured here because they generate assessments in greater detail, absent of aggregation errors (Berners-Lee et al., 2011; Ozawa-Meida et al., 2011). Baboulet and Lenzen (2010) used input-output analysis (IOA) informed with readily-available financial expenditure information of an Australian university as a means of assessing supply chain emissions of universities without any addition informational inputs. These can measure *total* environmental impacts of institution's activities (Mattila et al., 2010), whilst broadly hotspotting areas for improvement along the supply chain.

There is a notable absence of empirically supported full-scale EEIOA-LCA institutional footprints in the literature. Growing pressure to reduce emissions means that institutions are in danger of falling behind on pledged targets for direct emissions (Robinson et al., 2015), which subsequently lessens the probability of successfully managing and reducing Scope 3 emissions. The priorities currently favoured by universities in terms of promoting growth and economic fortune can conflict with the importance they assign to carbon management (Lozano, 2013); estate growth disproportionately magnifies scope 3 emissions occurring upstream and downstream of the organisational boundary (Sharp, 2009).

Universities serve a number of functions, influencing the activities they undertake and the GHG emission releases for which they are responsible. Specifically, the four major functions which universities serve (and from which, all other activities emanate) are in education, research, governance (Stephens et al., 2008; Sedlacek, 2013) and enterprise (Rae, 2010). Teaching perhaps influences the greatest number of activities and as a result, HEIs need not only be providers of physical learning facilities (such as lecture theatres, libraries, ICT equipment etc.), but a whole host of other amenities in order for students to thrive (such as health and wellbeing services; sports and social services; retail, food and drink outlets). For this reason, a comparison with small towns is often made (Zhang et al., 2011). The concentration of these amenities is highly disparate, with some universities based on a single location (a campus), multiple sites or scattered around cities. A rise in internet access means that traditional universities are moving activities online through distance-learning courses (Roy et al., 2008) and Massive Open Online Courses (MOOCs) (Barber et al., 2013) (examples include the Open University, Coursera and Kahn Academy).

Diverse infrastructure plays a key role in the delivery of degree programmes, which adds to the complexity of HEI carbon footprinting. Also, the nature of research programmes has also been seen to have a direct correlation with the energy-intensity of activities, often being cited as one of the primary reasons for contention when research-intensive institutions are compared to teaching-intensive institutions (Klein-Banai and Theis, 2013) and *vice versa*. The varying specialisms of universities, their demographic composition and financial leverage are additional contributors to this incongruence.

The reason for examining university carbon management in particular is to continue the debate of the role of HE on sustainability over the 21st century, whilst allowing institutions to position themselves favourably in tackling the future challenges associated with a changing climate (Barber et al., 2013). Universities play an influential role in providing technical solutions to climate-related issues (Sedlacek, 2013). Moreover, they are a pertinent case study organisation for assessing the relevance and applicability of carbon management standards. Their central role in education systems in all societies of the world transcend political regimes and economic systems (Meyer and Schofer, 2007). This presents a form of organisation that can be studied *anywhere* and understood *everywhere*.

This paper aims to make four key contributions to the literature: first, through highlighting the considerable disparities between carbon management standards designed for organisations; second, by identifying the key requirements for practitioners tasked with interpreting these standards; third, by proposing a universal methodology for universities as a surrogate for a generalised global organisational methodology and, fourth, by adapting and overcoming ubiquitous problems associated with data collection. This research focusses on UK HEIs but can be used as a barometer for present issues in campus sustainability departments in institutions across the world. A qualitative comparative analysis (QCA) (Gao et al., 2013) is conducted using a selection of frequently used organisational carbon footprinting standards, in-turn evaluated for their relation to the published literature through a systematic review. By combining these results with the results of a practitioner consultation, a framework for conducting organisational carbon footprints for universities is proposed. By accounting for the requirements of university environmental practitioners themselves, a series of recommendations are made which are sympathetic to the role that universities play and the activities they conduct.

2. Materials and methods

2.1. Systematic review: inclusion criteria

A systematic review was carried out to identify the theoretical underpinning of key ideas. Research papers were selected following a pre-determined set of criteria which amounted to (i) being written in English; (ii) featuring state-of-the-art knowledge, i.e. published on or after 1st January 2010 and not superseded by additional research; and (iii) being specific to the carbon footprint of organisations *and/or* HEIs. Often, elements of organisational carbon footprinting are research streams in their own right and are only applied to organisations retrospectively. In these instances, inclusion of papers was based on the importance of all search terms being present.

Search criteria were based on selecting papers that exhibited the terms ‘organis(z)ation’, ‘carbon’, ‘footprint’, and a selected additional ‘search term’. Here, the ‘search term’ refers to any one of the 55 phrases outlined in Table A.1 that describes procedural elements categorised by individual actions. The development of these used a methodology founded in Grounded Theory (GT); the individual

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constituent elements of pre-existing carbon management standards were coded and categorised into these phrases (Corbin and Strauss, 1998). This highlights the interconnectedness of the systematic review with latter sections of this paper, in particular the review of grey literature outlined in the proceeding Section (2.2). Papers included in this research study were full research articles; therefore, conference proceedings, reviews, and editorials were discarded.

2.2. Review of grey literature

To analyse the uniformity of existing standard guidelines, five of the most widely-used methodologies were chosen using the results from the annual Carbon Disclosure Project (CDP) survey on carbon strategies as outlined in Matisoff et al. (2013). These findings show the respective proportion of reporting organisations using carbon footprinting standards (See Table 1) and include: The GHG Protocol corporate accounting and reporting standard (2004) & corporate value chain (Scope 3) accounting and reporting standard; the DEFRA guidance on how to measure and report on corporate GHG emissions (2009); the ISO 14064-1 quantification and reporting of GHG emissions for organisations (2013) and the GRI G4 sustainability reporting guidelines (2013). The CDP guidance for companies reporting on climate Intergovernmental Panel on Climate Change (2014) was included due to the CDP's global significance in organisational carbon reporting; the HEFCE guides to good carbon management practice (2012) were also selected as a matter of course. A description of the authorities accountable to these standard guidelines is outlined in Table 2.

These methodologies were selected on the basis that they all have origins in the GHG protocol methodology developed by the WRI and WBCSD in 2004. This is regarded as the *de facto* standard for carbon accounting for organisations (Ascui and Lovell, 2012). Each has been somewhat successful in fostering action on emission reporting for corporate profit-driven organisations in its own right. For instance, the CDP is now the world's largest repository solely for carbon reporting, annually collating information for 1500 companies which contribute 26% of global anthropogenic emissions (Dragomir, 2012).

2.3. Consultation: UK university environmental practitioners

A workshop was undertaken at the 19th annual Environmental Association of Universities and Colleges (EAUC) conference at the University of Leeds in March 2015. A focus group was deemed the most direct method for collecting information about practitioner experiences of carbon management. Time pressures and venue limitations were among the push factors in preferring this method, whilst relative simplicity and the potential for shared-learning (Krueger, 1998) were significant pull factors.

The aim of the session was to understand the apparent gulf between the theoretical application of carbon standards and the real-world issues faced by staff at universities; participants were self-selected (as conference delegates). For many UK institutions, issues arise as a result of attempting to complete the annual estates management statistics (EMS) returns to the higher education statistics agency (HESA). Further investigation of these issues allowed for the identification of key requirements for a universal carbon footprinting standard for HEIs (known as user-sensitive inclusive design [Newell and Gregor, 2000]). A 40-min focus group discussion aimed at highlighting a series of broad-scale issues was followed by the administering of an individual questionnaire, designed with a series of Likert and semantic differential scale questions for classifying attitudinal attributes. The aim of both questioning methods was to answer four research questions:

- Q1 Which emission sources are the best understood in HEIs?
- Q2 Have difficulties been experienced to calculate data needed for the carbon footprint and if so, what can be improved?
- Q3 Do you think sector targets should be introduced which push institutions to calculate and subsequently reduce Scope 3 emissions?
- Q4 Would a universal standard methodology lead the sector closer in reaching carbon management goals?

2.4. Limitations

The limitations of this work must be noted. Although we have selected six of the most popular carbon management standards available in the grey literature for comparison and standardisation, the choices which practitioners have are not limited just to these. Certainly, the inclusion of standards here is by no means intended as a way for the authors to positively 'rate' their effectiveness at calculating and reporting GHG emissions. A fraction of the literature is excluded from comparisons because the focus is on meso-scale models (hybrid IOA-LCA). These models are somewhat more reliant on data inputs than say, macro-scale models, but offer the practitioner greater insight into process-level emissions.

Here we focus on engaging environmental practitioners at UK-based institutions. It could be argued that their broad role on many aspects of campus sustainability does not allow for building an in-depth knowledge on the academic underpinning of carbon management. Despite this, we deem these personnel to be a vital resource and the experts on their own institution's reporting structures. Consultation results suffer little from induced or preconceived response bias because of the variety of opinions received by respondents. The limited geographical spread of institutions can be extended, however the origins of the modern HEIs (based predominantly on the models set by the earlier institutions such as Cambridge, Oxford and the London Colleges) would suggest significant commonalities exist globally (Collini, 2012).

3. Findings

3.1. Appraisal of standards

The combined results of the systematic review and comparative analysis are found in the supplementary material. In total, 57 publications were interrogated, highlighting the considerable academic interest in organisational carbon footprinting methods since

Table 1
Implementation of standards by firms tested by the Carbon Disclosure Project (adapted from Matisoff et al., 2013).

Year	WBCSD/WRI[a]	DEFRA[b]	ISO[c]	GRI[d]	EU ETS[e]	IPIECA[f]	EPA[g]	CCAR[h]
	Percentage implementation by UK organisations (%)							
2007	41.1	10.7	1.3	1.6	3.6	1.3	0.0	0.0
2008	47.7	12.8	4.2	3.0	3.6	1.6	0.0	0.4
2009	54.7	20.0	10.0	6.9	5.9	2.4	0.2	1.2
2010	66.8	23.7	8.3	5.7	5.1	1.9	0.8	0.4

[a] WBSCD/WRI – World Business Council for Sustainable Development/World Resources Institute.
[b] DEFRA – Department for Environment, Food and Rural Affairs.
[c] ISO – International Standardisation Organisation.
[d] GRI – Global Reporting Initiative.
[e] EU ETS – European Union Emissions Trading Scheme.
[f] IPIECA – International Petroleum Industry Environmental Conservation Association.
[g] EPA – Environmental Protection Agency.
[h] CCAR – Californian Climate Action Registry.

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Table 2
Descriptions of the authorities included in this study, which governs the use of carbon management standards for organisational carbon footprint assessments.

Authority	Description
World Resources Institute World Business Council for Sustainable Development	The WRI is a research organisation that seeks to promote the sustainable use of natural resources. The WBCSD is a CEO-led organisation of forward thinking companies that galvanises the business community to create a sustainable future for business, society and environment.
Department of Environment, Food and Rural Affairs	DEFRA is a government department responsible for environmental protection, food products and standards, agriculture, fisheries and rural communities in the UK.
International Standardisation Organisation	The ISO is an international standard-setting body composed of representatives from various national standards organisations.
Global Reporting Initiative	Non-profit, promotes sustainability reporting as a way for organisations to contribute to sustainable development.
Carbon Disclosure Project	The CDP is an organisation that works with shareholders and corporations to disclose the GHGs of major corporations, amounting to some 3000 organisations.
Higher Education Funding Council for England	The HEFCE is a non-departmental public body of the Department for Business, Energy and Industrial Strategy (BEIS) that distributes public money to HE providers in England. It is mandate to ensure funding is used to deliver maximum public benefit.

2010. Organised by the four main principles of carbon footprinting identified in the peer-reviewed literature (boundary-setting, identification of activities, collecting of data and reporting/verification), these are further categorised into 32 variables and are in-turn disaggregated into 180 ‘constituents’. The grey-scale coding represents the degree of coverage exhibited by each constituent across all standards, ranging from 22% for the CDP standard to 60% for the ISO standard (see Table 3).

3.2. Results of the consultation

The questionnaire yielded 35 respondents from 31 individual institutions, representing a response rate by attendees of 66.04% (n = 53); an example can be found in Appendix A. Nevertheless, the sample is deemed sufficiently representative because 19% of the HEIs in the UK were represented (corresponding to a combined student population of 323,000). Questioning provided supporting information for the four original research questions:

Q1 Which emission sources are best understood?

The emissions categories reportedly calculated by each respondent can be seen in Fig. 1. Respondents were able to rate each emission source (as outlined in the ISO14064 standard) to reflect their institution's ability to fully quantify them with reliable data. This was based on four options: ‘reliable data, calculated fully’, ‘improved reliability but incomplete’, ‘basic understanding, some data collected but unreliable’ and ‘not currently calculated’. In the figure, data are arranged in descending order by emission sources rated as ‘*not* currently calculated’ by the respondent. Stationary combustion, mobile combustion, imported electricity, imported energy and waste were the most commonly calculated fully with the most reliable data (supported by more than half of respondents). Of these, stationary combustion and imported electricity (Scope 1 and Scope 2 emission sources) were found to be the best understood with the highest number (77%, n = 27) of responses.

Unsurprisingly, the majority of Scope 3 emission sources were not quantified with any certainty. For many, these sources have yet to be tackled and for reliable data to be obtained. For 91.4% (n = 32) of the respondents, both in-use stage of sold products and downstream leased assets were the least understood. In fact, responses for 10 of the Scope 3 categories reflected the inability of practitioners to quantify the impact of activities ranging from in-use emissions (from sold products) to upstream/downstream leased assets by more than 50% of respondents. This was only typical for two Scope 2 sources and for zero Scope 1 sources. The Scope 3 sources found to have been quantified with more reliability were: generated waste, business travel and employee commuting. These received the fewest ‘not currently calculated’ responses.

Q2 Have difficulties been experienced and if so, what can be improved?

Fig. 2 shows the results of a semantic differential question posed about attitudes towards the carbon footprint of the respondent's institution. The mean respondent's score is shown for each of the bipolar adjective pairs: adequate-inadequate; chaotic-ordered; open-secretive; complex-simple; old-fashioned-modern; ineffective-effective, and innovative-non-innovative. From this analysis, respondents exhibited a somewhat optimistic view of their institution's carbon footprint with a slight skew towards ‘ordered’ and ‘effective’. The strongest attitude overall was identified in the open-closed pairing which fell significantly in favour of ‘closed’. Although fewer negative connotations were identified, respondents also favoured ‘inadequate’ over the more positive alternative.

Respondents were asked to rate the factors that most influenced the quality of their institution's carbon footprint (see Fig. 3). Data reliability, staff resources, and time constraints had the highest rate of high impact responses, with the former two receiving 16 responses apiece. Whilst a mixed spread of responses was recorded, four of the eight factors recorded a response for ‘no impact’; namely budget constraints, staff training requirements, top management support and technical support (albeit from between one and three respondents only). Budget constraints and staff training requirements were less influential and received most responses in the ‘medium impact’ categories.

A number of specific issues were identified about data collection and reporting. Respondents expressed the view that they were often left to ‘fend for themselves’ when identifying the correct type

Table 3
Coverage of constituents from the six standard methodologies tested.

	GHG Protocol (2004) Scope 3 (2011)	DEFRA Guide on Measuring and Reporting GHG Emissions (2009)	ISO14064 Standard (2006)	Global Reporting Initiative Sustainable Reporting Guidelines (2013)	The Carbon Disclosure Project (2014)	HEFCE Guidelines (2012)
No. of constituents	98	47	107	45	39	51
Total constituents	180					
Coverage percentage (%)	54.44	26.11	59.44	25.00	21.67	28.33

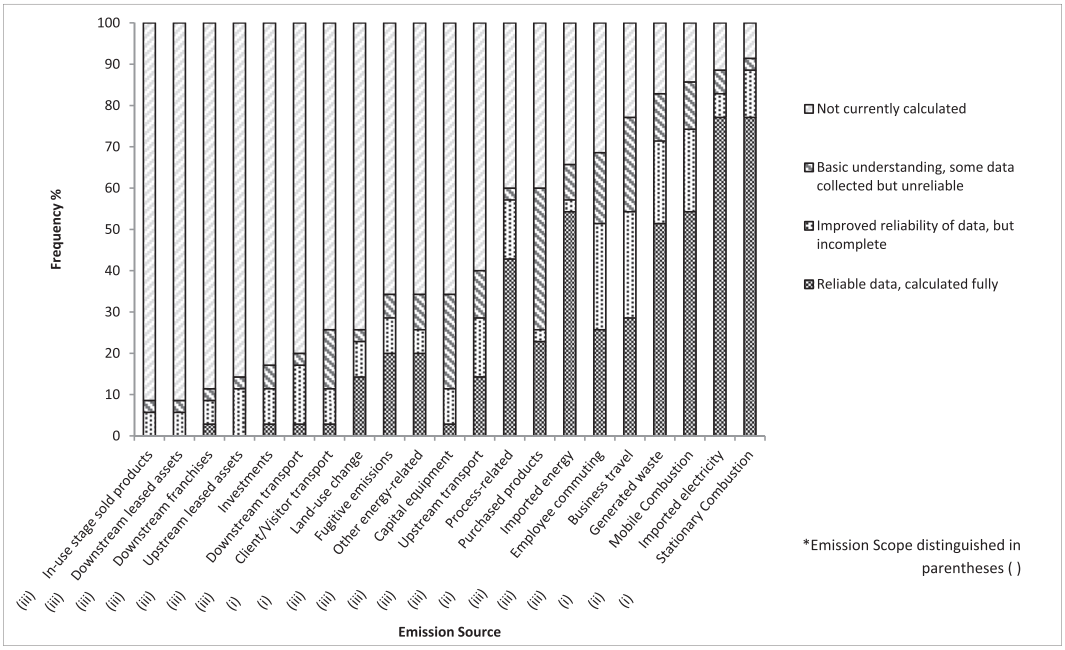

Fig. 1. The frequency of emissions sources calculated at the institutions represented by respondents. Emission source categories available for selection were based upon those in the ISO14064-1 standard.

of data sources. By following the guidance set by industrial bodies, respondents found the detail for data collection lacking. Where it was sufficient, this was limited to emissions sources where reliable data was already obtained, making the guidance somewhat irrelevant in places and directly attributable to their omission in returns to HESA.

Often, practical limitations caused data reliability issues. Access to data was restricted because of the complicated and external nature of some calculations. For instance, some institutions attempted to collect environmental information regarding purchased products directly from suppliers (citing the methodology which utilised financial "spend" data to be insufficient) but struggled to identify them or receive the information:

"… Getting data from suppliers is the most difficult for us …"

"Scope 3 calculation for procurement is very difficult to calculate as we purchase from tier 1, 2 and 3 suppliers. We don't always know where products are manufactured."

Doubt was expressed about the ability to quantify emission sources accurately. Individuals sometimes have to physically measure and/or obtain data from other employees across the estate and supply this to environment managers who are typically the focal the point for data and responsible for compiling reports. Respondents felt they had to scrutinise information from these sources particularly closely, citing the absence of a vested interest in ensuring the data supplied was authoritative and consistent.

"… The sources of information need to be managed better."

Often miscommunication between these employees was

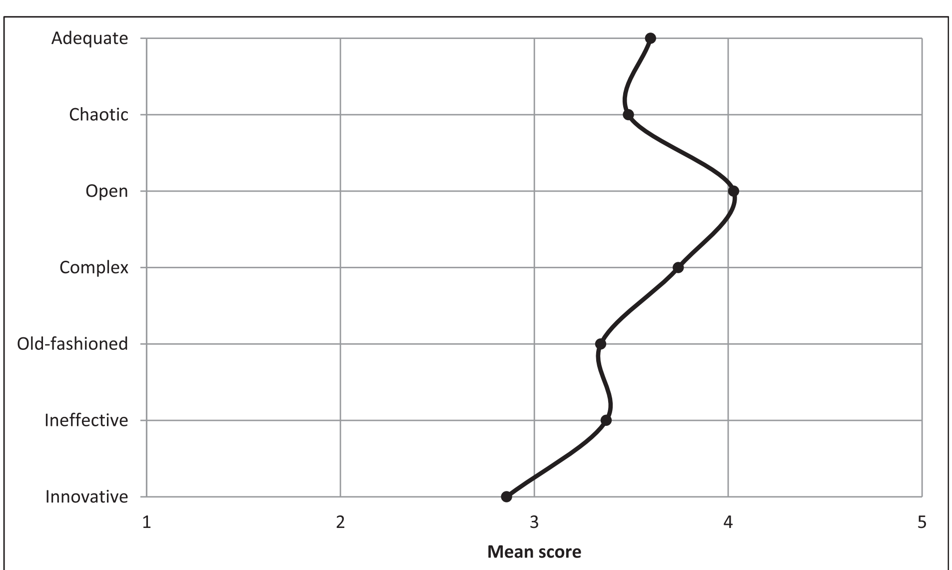

Fig. 2. Results of the semantic differential questions; respondents were asked to rate where their attitude placed along a continuum of adjective pairs.

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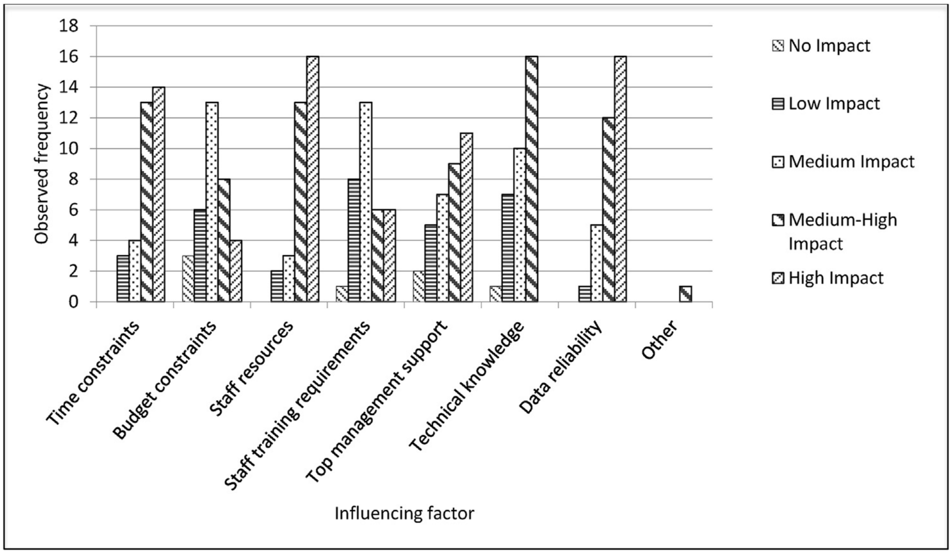

Fig. 3. Impact rating of factors influencing the full-scale calculation of the carbon footprint at the institutions represented by respondents.

experienced due to the number of people involved. In addition, respondents found that besides the lack of reliability in data discouraging the ability of HEIs to compare between peers, gaps in data exacerbated this problem:

"Simplify data collection to minimise gaps so that everyone has comparable data."

As a result, practitioners exhibited desire for a simplified process, in which obtaining a full data set was more likely. The practical-focus of responses meant that no respondents provided contrary answers regarding *extending* the current scope of mandatory reporting metrics.

Q3 Do you think sector Scope 3 reduction targets should be introduced?

It was clear that the level of preparedness required for pragmatic reduction targets was not yet in place. Respondents saw the current lack of Scope 3 emissions reporting to be a barrier to implementing targets in the short-term. Without good baseline years to inform targets, the strength of future reduction efforts was perceived to weaken. Time would be needed for institutions to produce reliable datasets, whilst further consultation and research would result in a more carefully designed set of objectives supportive of the needs of all institutions.

"If targets are based on years of high-volume construction or 'acts of god' then targets become irrelevant and lose the support of institutions."

Respondents were concerned with the probability of being portrayed unfairly as a result of differential reporting. The heterogeneity of the data reported by institutions was deemed significant enough to deter them from wanting performance-based targets associated with Scope 3 emissions. Whilst an institution might have taken responsibility for, and reported all indirect emission sources, respondents foresaw the potential for their institution to receive negative publicity. This forms a paradox when comparing institutions with those reporting lower emissions (as a result of understanding fewer emission sources across the estate); on the surface, the latter institution 'performs' better in the eyes of the media, funders and peers. As a result, these actions were predicted to lead to potential reputational damage:

"Institutions would only report on Scope 3 emissions if everyone else was doing it!"

Respondents also suggested that a lack of control over emission sources was a factor in not supporting Scope 3 targets. Ultimately, if such targets were necessary, then being disaggregated by activity type was favoured. An all-encompassing target was criticised because it would be impractical for the majority of institutions; even the most experienced institutions would struggle to manage the full breadth of activities in the short term. Indirect targets, based on behavioural change, were deemed highly favourable to influence emission reduction. Institutions already manage their waste, have a travel plan and a procurement policy, and so focussing on areas where they currently direct efforts through sustainability measures were regarded as more sensible.

"In reality, if this was to be introduced, it would have to be a target broken down for each of the emission sources in order to be meaningful and attainable."

Despite a general feeling against the introduction of Scope 3 targets, it was clear that all respondents shared a desire to manage emissions arising from indirect activities. In addition, all respondents supported the notion that the reporting of these sources should be mandatory and coupled with a published management plan:

"Reporting and having a plan to manage Scope 3 should be mandatory, but not carbon targets!"

"It is important that reporting is mandatory."

This is somewhat contradictory of answers gleaned from Q2 and evidently, a fine balance between oversimplifying the GHG assessment process and dismissing ethical and altruistic responsibilities and the abilities of overstretched environmental practitioners was highlighted.

Q4 Would a universal methodology improve the *status quo*?

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Practitioners reported a desire to prioritise carbon management as it was *"seen as the right thing to do for responsible organisations"*. The respondents demonstrated a general positive reaction to the idea for a universal methodology, believing that this would lead to an increased number of institutions fully reporting emissions for the full breadth of activities. Forty percent (n = 14) agreed that a universal, comprehensive standard would be beneficial to their home institution. Thirty-one percent (n = 11) strongly agreed that the number of institutions undertaking full-scale carbon footprints would increase, as there was a perception that if all institutions followed the same method, better comparability would instil the confidence to report emissions.

A number of points were outlined that advocated a universal methodology for reducing the influence of a number of perceived issues. For instance, many practitioners found that prescriptive and standardised guidance could reduce the loss of knowledge that can occur when individual staff members depart the institution:

> *"A universal standard for HEIs would go a long way to solving issues around members of staff leaving and taking certain methodologies that have taken years to produce with them …"*

For institutions with very small environment and sustainability teams, this was found to be an even more significant consideration. However, the key to switching current approaches and adopting any of the proposals outlined was university leaders seeing the financial benefits, suggesting that the decision was not theirs to take:

> *"The number of institutions using a universal carbon footprint would depend on the financial situation of the HEI."*

When asked about the likelihood of their institution using a universal methodology, a skew towards 'very likely' was evident (34% (n = 12) of respondents made that selection). In addition, there were calls for this methodology to be used in urging the HEFCE to change its stance on carbon management in favour of something designed *'by the sector, for the sector'*.

4. Discussion

4.1. The organisational carbon footprinting process

Organisational carbon footprinting is typically a four-step process (Gao et al., 2013), characterised by: (i) setting the organisational boundary (identifying the facilities that should be accounted for); (ii) establishing the operational boundary (the activities for which the organisation deems itself to be responsible for); (iii) quantifying the carbon footprint (through collection of appropriate activity data); and, (iv) reporting and verifying the result (Dragomir, 2012; Gao et al., 2013; Pelletier et al., 2013). The methodologies involve the practitioner identifying the activities they are responsible for in separate emission Scope categories upstream and downstream of their organisation's operations. This is based upon a hybridisation of methods used in [*environmentally-extended*] input-output analysis and life cycle assessment (EEIOA-LCA) (Peters, 2010); two well-established fields of carbon assessment at opposite scales.

A number of key pieces of literature identified in the systematic review have highlighted recent augmentations to the organisational carbon footprinting process. For example, Pelletier et al. (2013) attempted to develop a new methodology for the European Commission (EC) based on a number of criteria, aiming for a new method which was: inclusive of the lifecycle emissions across the supply chain; reproducible; comparable (as opposed to flexible); and physically realistic. Others, have vocalised the need for Scope 3 methodologies (Stubbs and Downie, 2011) and established preliminary research that can be taken forward in making this a reality. A few examples of full-scale Scope 3 carbon footprints have arisen, but these changes have not yet proved radical enough to increase the number of organisations reporting Scope 1, 2 & 3 carbon footprints; our search criteria identified only three examples (see: Larsen and Hertwich, 2009; Letete and Marquard, 2011; Ozawa-Meida et al., 2011). Often, the choices that make such methodologies applicable to a wide audience are removed in the hope of maintaining simplicity (Pandey et al., 2011). However in the process, truncation errors are introduced and the Scope is narrowed without sufficient explanation.

Some would argue that little progress has been made since the publication of the first GHG protocol in 2001, which had been hailed as a major breakthrough in environmental advocacy and widely adopted and accepted since (Green, 2010). There has been little in the way of developing this methodology to account for the changing need of carbon reporting in the intervening 15 years; a time of rapid adoption of environmental legislation (Tews et al., 2003; Jordan et al., 2013). As a consequence, the scope for change is equally and simultaneously significant in its potential, but encumbered by well-established methodologies.

By clearly delineating the steps required in conducting an organisational carbon footprint, the process can be understood in its entirety and evaluated for its functionality. The commonalities identified as a result of our analysis means that we can build upon this relationship to propose Fig. 4 as a more complete description of the organisational carbon footprinting process. These four steps are supported by the themes 'scoping', 'conceptualising' and 'communicating', which help to distinguish the individual actions required of the environmental practitioner. 'Scoping' incorporates two steps: the setting of the organisational boundary and the identification of the organisation's activities (conducted using a control approach or equity share approach). 'Conceptualising' refers to the collection of activity data (itself categorised into operational[2] and non-operational[3] data) and the application of the carbon equation. 'Communicating' describes the reporting of carbon information to key stakeholders in an understandable format, which is externally verified, to ensure reliability and maintain rigour. Additionally, an initial theoretical reconciliation is made to the constituents by accepting those with coverage greater than 66.6% (as can be seen in the column in the Supplementary Material marked 'Reconciled'); this captures 24 of the 180 constituents (13.3%) i.e. 'setting an emission baseline' and 'defining the organisational boundary'.

Combining these initial changes with the results of our analysis, a number of interrelated issues are identified. These are listed below alongside simple corresponding improvement solutions:

- i a There is no guidance on clearly deciding whether activities are to be included or excluded, leading ultimately to a high level of double counting. When EEIOA-LCA footprints are reported, double counting is unavoidable since these activities overlap with many other organisations;
- i b Potential solution: The implementation of simple cut-off criteria would allow the user to make a definitive in-out decision of activities along the supply chain.

****

- ii a There are deficiencies in time, cost and staff resources in organisations, which means that the process cannot be

[3] Non-operational data is defined by the author as data that requires manipulation in order to obtain an emissions profile.

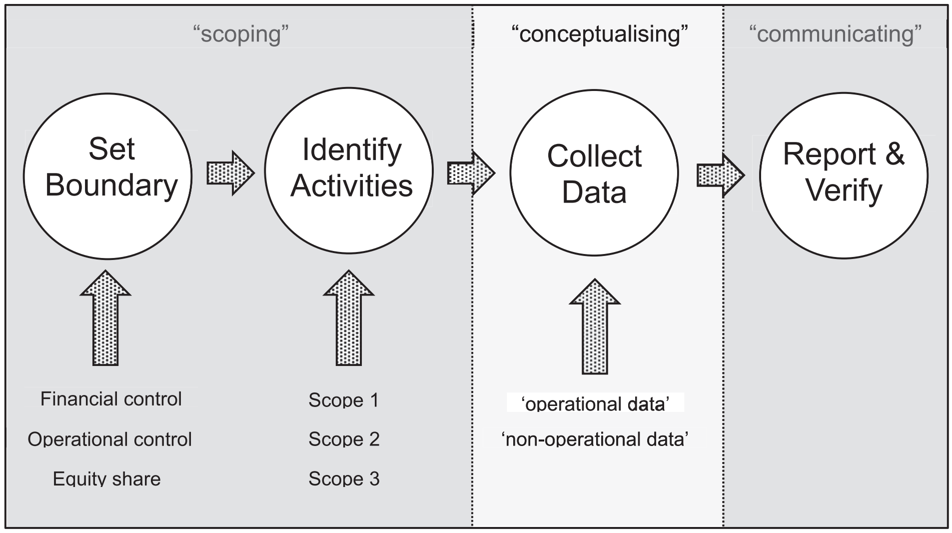

Fig. 4. The relationship between the seven principles of organisation carbon footprinting.

conducted to the 'end' (defined by the standards or the reporting organisation);

ii b Potential solution: Minimise the number of actions required by environmental practitioners.

****

iii a The description of data collection methods is not clear nor prescriptive, making reliable or useful inferences from data impossible;

iii b Potential solution: Introduce guidance outlining methods for the robust activity data collection, which is appropriate for the resolution and aim of the footprint.

****

iv a The GHGs included are inconsistent, potentially leading to false reporting and high margins of error.

iv b Potential solution: Standardise the GHGs included in the footprint.

A second column is added to the Supplementary Material labelled 'Robinson et al. proposed'. This incorporates reconciled constituents with additional ones that are deemed imperative to the functioning of the methodology ($n = 77$). Sixteen constituents are made 'dependent', where their inclusion is subject to certain considerations, and dismissing them outright would be inappropriate. For example, constituents referring to the manufacture or use of products for sale or the operations of franchises may not be applicable to all universities but the scope for their inclusion cannot be disputed, when considering that the activities of universities are highly variable.

A number of constituents have been omitted, following decisions to ensure parity with the suggested improvements (supported by the systematic review); three instances can be highlighted. Previously, practitioners had been given the option to choose which approach they took to setting the organisational boundary. Now, only the entities through which the organisation can enact meaningful carbon reduction measures are considered (through the allocation approach based on financial or operational control) (Pelletier et al., 2013). Secondly, through the use of data scenarios, an illustration of the best, minimum and intermediate quality data is provided (British Standards Institute, 2013). Ensuring all footprints conform to an acceptable degree of accuracy has become a central idea, controlled much more closely through the verification process. Finally, the GHGs included are aligned with those outlined in Wright et al. (2011), who formed a definition inclusive of only two GHGs (CO_2 and CH_4) based on their contribution to global anthropogenic emissions. This standardisation is important owing to the variability found in all standards and the literature; with authors favouring solely the accounting of CO_2 (such as Recker et al., 2011; Chakraborty and Roy, 2013; Rietbergen et al., 2015), or the seven Kyoto basket GHGs (referred to as a 'climate footprint') (Dragomir, 2012; Williams et al., 2012a,b; Matisoff et al., 2013).

4.2. Cut-off criteria

The difficulty in assigning responsibility for emissions has been well documented and still remains a highly divisive topic in the literature (Bastianoni et al., 2004; Stubbs and Downie, 2011). For internal use, carbon footprints that detail the emissions arising from all activities under the influence of the reporting organisation are a highly useful decision-making tool (Lenzen, 2008) that allow organisations to exert a greater degree of control over their activities which impact on the environment (Dragomir, 2012). Upon aggregation of multiple organisations comprising a sector, the resulting figure is artificially inflated and the accuracy undermined (Dragomir, 2012), therefore proving to be less effective for carbon management on a sector-wide scale (Andrew and Cortese, 2011). Cut-off criteria establish a set of rules that assist the environmental practitioner in deciding which activities should be included and which should be excluded in their footprint (after organisational and operational boundaries are set [Dias and Arroja, 2012]). Thus, they offer a potential way of improving the accuracy and usability of reported figures and assist in addressing [i a] and [ii a] in the list of issues outlined above.

Simple criteria comprise: i) the exclusion of paid-for Scope 3 products and services (as these are the Scope 1 or 2 emissions of another organisation); ii) the exclusion of activities with any potential to be counted elsewhere and iii) include the business-critical and geographically significant activities (i.e. Scope 1 and 2).[4] The potential for double counting is eradicated because only emission-releases

[4] These are included as default, due to a robust assigning methodology being already widely accepted by the academic community.

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arising from production-related[5] activities would be reported by organisations and aggregated by sector. Activities along the supply chain are assigned to the producer, meaning that time and financial savings can also be realised for the reporting organisation. The consequences of introducing cut-offs can be seen in the final column in the Supplementary Material; the number of constituents now equals 90. Yet, fully removing the ability for organisations to understand climate impacts at this scale would be counter-productive due to their usefulness in aiding policymaking decisions. Therefore, we propose that two figures should be produced by organisations: i) a 'catch-all' figure that is used for internal strategic carbon management planning; and ii) a 'minimum standard' that details emissions through the employment of the cut-off criteria.

Certainly, the use of cut-offs isn't without controversy and have been dismissed in the past for their tendency of being arbitrary and for producing inconsistencies (Huang et al., 2009; Pelletier et al., 2013). Whilst this isn't the only proposed solution to double-counting of aggregated organisation emissions (shared responsibility, has been shown to be an effective compromise [Gallego and Lenzen, 2005 & Lenzen et al., 2007]), our proposal for three well-defined instructions addresses assumptions and streamlines the process from beginning to end. This is advantageous because often, the greater the time spent collecting and preparing information for organisational carbon footprints, the costlier the process becomes (whilst improvements to accuracy are negligible) and the less accessible it is (Plambeck, 2012). Eventually, a threshold is reached beyond which the cost to the organisation exceeds the exploitable benefits ('the law of diminishing returns' [Shephard and Färe, 1974]). Therefore this methodology, which prioritises directly influenced and production-based emissions, removes barriers to carbon footprinting by ensuring organisations remain far removed from any threshold.

With the number of environmental carbon standards growing, the introduction of a new methodology could 'muddy the water' of an already complex field. Despite this and the disadvantages noted by some on the use of cut-offs, there is a global market for process standardisation which supports a move towards a universal approach presented here. This is demonstrated by the existence of organisations such as ISO (which in-turn is comprised of representatives from 162 national standard-setting bodies), ASTM International and the International Electrotechnical Commission, whom combined, are responsible for setting more than 50,000 standards worldwide. It is important that standards are fit-for-purpose and therefore, challenging and promoting the adoption of new approaches, designed and chosen by users themselves is wholly advantageous.

Beyond the more immediate regulatory measures which organisations are governed by, having a clear understanding of environmental impacts allows for better contingency plan and improved recognition of emerging risks (of operations and financial investments) (Hoornweg et al., 2011). This allows organisations to be better placed in contributing to society's climate adaptation in the coming decades (Hulme, 2003; Linnenluecke and Griffiths, 2010), whilst facing up to the increasing significance placed on business resilience through good carbon management (Williams et al., 2012a,b). The appetite for honest environmental claims has never been greater, coupled with a growing popularity of conscious consumerism (Sullivan and Gouldson, 2012). Organisations fail to engage on this agenda at their peril, as failing to do so would mean missing out on a vast swathe of potential customers and revenues.

4.3. University carbon footprints: practical realities

Evidently, a 'one-size-fits-all' approach is common across all of the environmental standards interrogated. However, it remains to be seen how suitable this approach is in promoting pragmatic carbon management in the real world. Arguably, the lack of GHG reporting of Scope 3 activities by organisations is indicative of deficiencies in the methodology. For universities in particular, funding pressures and time constraints are the reasons most cited for avoiding or underperforming on carbon management, which is exacerbated by the changing influence of policymakers. Currently, the sector is facing a lack of direction on carbon-related policies, especially in regards to the management of Scope 3 emissions. The issues arising from this are only just starting to be realised. For instance, there are early indications that predict a collective failure on targets enacted in 2010 to reduce Scope 1 and 2 emissions by 2020 (where 2015 represented the halfway point) (Robinson et al., 2015). The lack of cohesion and clear direction is having tangible and potentially damaging consequences, whilst the bodies that control both the direction and pace of progress, have seen their influence wax and wane through concurrent UK government shake-ups over the last decade (Universities UK, 2015).

A streamlined and prescriptive methodology, based on empirical evidence, emerging out of a sector-wide collaboration is a logical first step in addressing these issues. Whilst it cannot be said that scientific expertise is lacking or governments have been inactive in this field (in fact, DEFRA itself commissioned an input-output assessment of UK emissions (Wiedmann et al., 2009); data which organisations can use to support IOA-based footprints), the knowledge within universities needs nurturing. Similarly, a perception that collecting data (internally and from external suppliers/organisations) is an obstacle to developing reliable GHG assessment has emerged, despite readily accessible financial accounts, with which detailed upstream footprints can be calculated (Wiedmann et al., 2009; Townsend and Barrett, 2015). Now more than ever, there is a requirement for clarity in a time of significant change for carbon management in the sector. With the introduction of new funding policies and universities playing an increasingly key role in local and national policymaking, the traditional outputs of universities (the intellectual 'assets' [Collini, 2012]) are being tested and developed. HEIs are under increasing demands to demonstrate their direct financial contributions to the economy (Etzkowitz et al., 2000) and as a result, growth and expansion have been inevitable. Although wholly welcome by those responsible, the impact on indirectly influenced emissions is unknown and for these reasons, the future for Scope 3 carbon management in particular remains uncertain.

Universities act to transfer knowledge between industry, government and the public (described by Etzkowitz (1998) as the triple helix model) and for this reason, can also act as good influencers of carbon management in wider society and other organisations (Lozano et al., 2013). Rapidly changing estates, transient populations and different academic specialisms mean that the variety and intensity of activities are in constant flux (with timings dictated by the structure of the academic year) (Flint, 2001). Critically, they find themselves needing to fulfil certain mandatory responsibilities and activities, which are driven by their research, teaching and innovation-based agendas. Consumption-based activities dominate the emission profile, whilst activities such as travel, procurement or construction are inherently strategic, important and thus, unavoidable (Ozawa-Meida et al., 2011). Those that work and study at university will spend a large majority of their lives there and so, investing in sustainability initiatives at the grassroots level through HE, can and will have wide reaching benefits to students and staff for the rest of their lives (Zsóka et al., 2013); and not forgetting the

[5] Production-based emissions are allocated to the organisation that generated them, whilst consumption-based emissions are allocated to the organisation whose consumption caused the emission (Hoornweg et al., 2011).

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societal benefits too. To add to the significance of Scope 3 emissions, the emerging commodification of HE has promoted institutions to establish campuses internationally, in order to cater for and exploit the demand in HE around the world (Universities UK, 2012); such as in South East Asia (Altbach et al., 2009).

4.4. University carbon footprints: scoped-out activities

Table B.1 shows site-specific activities listed under each of the ISO-designated emission categories and the treatment applied under the proposed methodology. Some may argue that the treatment of these activities could provide a case for universities to abstain on carbon management because the majority of Scope 3 sources are excluded. Likewise, the shifting responsibility of emissions from the HEI to their suppliers could enable institutions to continue their current trajectory of growth and increasing consumption without due regard for environmental consequences (Jackson and Knight, 2011). Whilst this may hold some weight, the reason this has been allowed to flourish already can in-part be attributed to the policy situation already described. The methodology outlined here considers these issues in a number of ways and allows institutions to address them individually. Firstly, universities are still held to account because of the emphasised importance of developing full-scope carbon footprints for *internal* use (to aid carbon management) and secondly, the reporting has been made easier for GHGs *within* their organisational boundary.

A responsibility now falls onto the various agencies that govern the HE sector to foster collaboration on understanding an individual institution's carbon management needs. Ensuring that institutions are able to report data (currently controlled by HESA using the Higher Education Information Database for Institutions (HEIDI) and are compared fairly (by using carbon intensities to compare similar-sized institutions) removes the many unwanted barriers that can pose a threat. In addition, this study should serve as a wakeup call to policymakers and institutions that more work needs to be done to decouple growth from emissions (Pelletier et al., 2013). This joins those from other academic research and grassroots movements (such as the global divestment movement and rootAbility's Green Office initiative). Whilst universities should retain the right to grow nationally and internationally, new ways of delivering HE with a lower environmental impact must be a priority, whether managing the estate more efficiently or challenging the traditional methods of teaching to favouring distance-learning and offsite degree courses (Barber et al., 2013; Roy et al., 2008).

The use of carbon footprinting can assist in creating better ownership by individuals in organisations like HEIs (Paterson and Stripple, 2010). As individual stakeholders of HEIs, getting staff and students to take a more central role in contributing to carbon management is important in fostering significant reductions. A cost for carbon, in-line with the published figure of the social cost of carbon (the cost to society as a result of environmental damage caused by anthropogenic GHG emissions) could be introduced by manufacturers and purveyors of services. This would negate any possibility of allowing staff and students *carte blanche* on highly-consuming behaviours. Consequently, the cost of emissions is borne by the consumer and so a potential win-win scenario is presented. This influences the behaviour of the consumer through selecting products and services with the least environmentally damaging credentials. In-turn, the provider adapts favourably to remain competitive and maintain market-share; Grote et al. (2014) considered this in an example of the aviation industry - by increasing ticket prices for flights as a means to reduce aviation emissions, considerable emissions savings could be predicted. However, the low probability that strong policy decisions will be taken offers little certainty about the future trajectory of carbon reduction.

5. Conclusions

Scope 3 emissions represent the largest proportion of the organisational carbon footprint, but are seldom the priority in carbon management policies (Ozawa-Meida et al., 2011). The three most influential barriers to assessing and reporting indirect GHG emissions from upstream and downstream of the organisational boundary of HEIs have been identified as time, cost and data reliability. HEIs transpose key theories from guidance notes, intended to be suitable for all organisation types. Along with inconsistencies in the grey literature, a limited number of institutions have a detailed understanding of GHG emissions associated with all of their directly and indirectly influenced activities.

A universal methodology which takes a consistent and transparent approach for practitioners in assessing the carbon footprint of HEIs is proposed. The input of environmental practitioners themselves during its development has sought to ensure this methodology is user-friendly. We have shown that whilst the virtues of understanding all emissions for which an organisation is responsible are clear for implementing appropriate sustainability initiatives, when reported, inherent double-counting undermines conclusions that can be made about entire economic sectors. Therefore, the use of full-scale footprints for internal purposes and the external reporting of production-based emissions are proposed. With the latter, cut-offs that exclude paid for services are outlined to reduce the financial and temporal cost associated with reporting and data collection. We think that our approach and universal methodology would be suitable for adoption by all types of organisations, regardless of region or sector.

The year 2015 represented the halfway point between the setting of institutional targets in 2010 to reduce Scope 1 and 2 emissions by 2020 (HEFCE, 2010). The interest and desire to manage indirect GHG emissions exists in the HE sector today, but the tools in order to do this are yet to be put in place. Carbon management will be a cornerstone for institutions aspiring to grow internationally at a time when advocating sustainability and low-carbon production is high on the list of priorities (Lozano et al., 2013). Clearly, the time to act is now.

This paper forms the basis of efforts to improve Scope 3 GHG emission reporting rates for HEIs. Future work aims to investigate the current practices that HEIs undertake to assess their GHG emissions using these techniques in order to build upon the findings presented here. Identifying exactly which of the barriers recognised by practitioners can be addressed through employing a streamlined carbon footprint methodology will extend the scope of this research. In particular, the degree to which this method fosters more efficient use of the time and financial resources available to non-technical personnel (such as the university environment managers that formed the basis of this research) will be the subject of further study.

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Appendix A

Carbon management at universities: towards a universal method for calculating scope 3 emissions

This questionnaire allows you to have your say on what you want to see from a universal and comprehensive set of industry carbon footprinting guidelines. By completing it, you consent to the data you provide being used for this study as outlined in the participant information sheet (13/03/15_2). Your participation is voluntary and you are free to stop filling in the questionnaire at any time and without providing a reason.

Section 1: You and your institution

1) Which region of the UK are you from?

*(Please tick **one**)*

- ☐ Northern Ireland
- ☐ Scotland
- ☐ North East
- ☐ North West
- ☐ West Midlands
- ☐ Yorkshire
- ☐ East Midlands
- ☐ West Midlands
- ☐ East
- ☐ South West
- ☐ South East
- ☐ London
- ☐ Wales

2) What is the name of your institution/organisation of origin?

3a) Does your institution outsource work to calculate the carbon footprint?

(This includes any work outsourced at any stage to collect or analyse data)

- ☐ Yes
- ☐ No

3b) If yes, which company do you use?

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4) Please indicate on the scale your attitude towards your institution's ability to calculate its carbon footprint

*(Please make your rating by circling **one** on each scale)*

Adequate				Inadequate
4	3	2	1	0
Chaotic				Ordered
0	1	2	3	4
Open				Secretive
4	3	2	1	0
Complex				Simple
4	3	2	1	0
Old-fashioned				Modern
0	1	2	3	4
Ineffective				Effective
0	1	2	3	4
Innovative				Non-innovative
4	3	2	1	0

5) Please rate how much of an impact the following factors have in the calculation of the carbon footprint at your institution

*(Please circle **one** for each statement)*

	No Impact				*High Impact*
Time constraints	0	1	2	3	4
Budget constraints	0	1	2	3	4
Staff resources	0	1	2	3	4
Staff training requirements	0	1	2	3	4
Support from top management	0	1	2	3	4
Technical knowledge of procedures	0	1	2	3	4
Data reliability	0	1	2	3	4
Other	0	1	2	3	4

If other, please specify:

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6a) Does your institution use a published methodology for guidance in calculating emissions?

☐ Yes ☐ No

6b) If yes, which methodology is used? *(Please tick **one**)*

- ☐ HEFCE 2010, carbon management series of guidance documents
- ☐ IPCC 2006, guidelines for National GHG inventories
- ☐ GHG Protocol Corporate Accounting Standard 2004 & 2011
- ☐ ISO 2006, 14064-1 Specification
- ☐ DEFRA 2009, Guidance on how to measure and report your GHG emissions
- ☐ GRI 2013, emission guidelines - G4 Sustainability Reporting Guidelines
- ☐ CDP 2014, Guidance for companies reporting on climate change
- ☐ Other

If other, please specify:

HEFCE – Higher Education Funding Council for England, IPCC – Intergovernmental Panel on Climate Change, ISO – International Standardization Organization, DEFRA – Department for Environment, Food and Rural Affairs, GRI – Global Reporting Initiative, CDP – Carbon Disclosure Project

7) Which emission sources does your institution have a good understanding of?

(Please label the following sources with the appropriate level of understanding at your institution)

0 = not currently calculated; 1 = basic understanding, some data collected but unreliable; 2 = improved reliability of data, but incomplete; 3 = reliable data, calculated fully)

Scope 1	Scope 2	Scope 3
☐ Stationary combustion (boilers)	☐ Imported consumed electricity	☐ Other energy-related sources
☐ Mobile combustion (vehicles)	☐ Imported energy (heat/steam)	☐ Purchased products
☐ Process-related emissions		☐ Capital equipment
☐ Fugitive emissions		☐ Generated waste
☐ Land-use change/forestry		☐ Upstream transport
		☐ Business travel
		☐ Upstream leased assets
		☐ Investments
		☐ Client and visitor transport
		☐ Downstream transport
		☐ In-use stage of sold products
		☐ Downstream franchises
		☐ Downstream leased assets
		☐ Employee commuting

Definitions:
- **Process-related emissions** – Emissions from biological, mechanical or other activities not arising from direct combustion or leaks from equipment/storage systems
- **Fugitive emissions** – Direct uncontrolled emissions of GHGs leaked from equipment/storage systems
- **Other energy-related sources** – Emissions from the extraction, production, transport and distribution stages prior to fuel use/energy consumption
- **Capital equipment** – Emissions from production of capital goods – equipment used by organisation to manufacture a product, provide a service etc.

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Section 2: expectations of a universal, comprehensive standard

8) Please rate your agreement with the following three statements:

*(Please circle **one** for each statement)*

8a) *"A universal, comprehensive carbon footprinting standard should focus on better data collection"*

Strongly agree — Strongly disagree

0 1 2 3 4

8b) *"I should be able to relate a universal, comprehensive carbon footprinting standard to my organisation's own requirements and economic/environmental context"*

Strongly agree — Strongly disagree

0 1 2 3 4

8c) *"I require step-by-step instructions to calculate my organisation's carbon emissions"*

Strongly agree — Strongly disagree

0 1 2 3 4

9) Please rate your preference for the following:

9a) What is your preference for a universal method which encompasses the greatest extent of emissions but represents the greatest economic and temporal cost?

Cheaper, quicker — *Expensive, slower*

0 1 2 3 4

9b) To which extent should the use of technology be employed in a carbon footprinting standard?

Manual — *Technological*

0 1 2 3 4

9c) What is your preference for an all-encompassing carbon footprint over one that is less extensive (if the latter were cheaper, quicker and equally comparable)

Bounded footprint — *Boundless footprint*

0 1 2 3 4

Section 3: opinions of a universal, comprehensive standard

10) How likely are you to use a universal, comprehensive methodology?

*(Please circle **one**)*

Very likely *Very unlikely*

0 1 2 3 4

11) Please rate your agreement with the following statements:

*(Please circle **one** for each statement)*

11a) *"A universal, comprehensive standard would be beneficial to* my *institution"*

Strongly agree Strongly disagree

0 1 2 3 4

11b) *"A universal, comprehensive standard would be beneficial to* all *UK institutions."*

Strongly agree Strongly disagree

0 1 2 3 4

11c) *"The number of institutions undertaking full-scale carbon footprints will increase as a result of a more universal standard."*

Strongly agree Strongly disagree

0 1 2 3 4

12) Has today's workshop inspired you to adopt different carbon measurement practices?

☐ Yes ☐ No ☐ Maybe

13) Are there any other comments you wish to make regarding this research?

(Please continue on the reverse if more space is required)

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Would your institution like to participate in an extended study of this research project? If so, please list your email address and a named contact below:

Email address: ____

Name: ____

Institution Address: ____

____

____ Post Code: ___________

Table A.1
Procedural elements of organisational carbon footprinting used as search terms in the systematic review.

Emission baseline (benchmark/base year)	Equity share or control boundary-setting approach (organisational boundary)	Temporal boundary	Emission Scopes: 1, 2 and 3
Upstream/downstream	Direct emissions from stationary combustion (on-site energy production)	Direct emissions from mobile combustion (vehicle fleet)	Direct process-related emissions
Direct fugitive emissions	Direct emissions/removals from Land-use, Land-use Change and Forestry	Indirect emissions from imported electricity consumed (purchased electricity)	Indirect emissions from consumed energy imported through physical network (purchased steam, chilled water)
Energy-related activities not included in direct & energy indirect emissions (Scope 1, 2 life cycle emissions) Upstream emissions of purchased fuels Upstream emissions of purchased electricity Transport/distribution losses Generation of purchased electricity sold to end users	Purchased/procured products (Product lifecycle assessment (LCA) – cradle-to-gate emissions)	Production-related procurement	Non-production-related procurement
Capital equipment (goods)	Waste generated from organisational activities	Upstream transport/distribution Transport and distribution of purchased products Third-party transportation and distribution services purchased	Business travel (staff travel)
Emissions from business travellers in hotels	Upstream leased assets	Investments	Client and visitor transport
Downstream transport and distribution	Emissions from retail and storage	Use stage of sold product Direct use-phase emissions Indirect use-phase Maintenance of sold products	End of life (disposal) of sold product
Downstream franchises	Downstream leased assets	Employee commuting	Land-use
Emission calculation (activity data x emission factor)	Carbon dioxide only	Kyoto Basket GHGs (six: CH_4, N_2O, HFC, PFC, SF_6)	Air pollutants
Published emission factors (i.e. not from a national database)	National emission factors (DEFRA, Bilan Carbone, IPCC, IEA)	Organisation-specific factors	Use of data scenarios (best, inter, min)
Centralised [*data collection*] approach	Decentralised [*data collection*] approach	[Reporting] Acknowledgement of significant emissions changes	[Reporting] Assumptions (Standards and methodologies used)
Intensity ratios (normalised)	Disaggregated emissions	[Report] Excluded emission sources	Uncertainty analysis
Base year recalculation policy	Internal performance tracking	Scope 1 and 2 emissions independent of GHG trades, sales, purchases, transfers, banking allowances	Emissions data separate for each Scope and Scope category
Metric tonnes and in tonnes of CO_2 equivalent	Emissions data for direct CO_2 emissions from biologically sequestered carbon (e.g. CO_2 from biomass/biofuels) reported separately	Set targets/guidelines for target-setting (SMART)	

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Table B.1
Treatment of activities attributed to a university estate after applying the methodology proposed in this research paper.

ISO Designation	Description	Site-specific Activity	Treatment
Direct emissions from Stationary Combustion	Energy/heat Production	Use of boilers	IN
		Use of CHP	IN
Direct emissions from Mobile Combustion	Use of Vehicle Fleet	Interlibrary book loans	IN
		Use of plant machinery	IN
		Transport of maintenance personnel	IN
		Attendance of international conferences	IN
		Attendance of domestic conferences	IN
		Outreach activities	IN
		Field Trips	IN
		Fieldwork	IN
Direct Process-related Emissions	Agricultural processes	Livestock	IN
		Application of nitrogen fertiliser	
		Putrefaction/fermentation	
	Waste-related processes	Waste treatment	
		Wastewater/sewage treatment	
Direct Fugitive Emissions	Energy-related processes	Natural gas storage	IN
		Transportation of Natural gas	
	Miscellaneous	Use of fire CO_2 extinguishers	
		Use of CO_2 in gaseous or solid form	
Direct Emissions and removals from Land-use, Land-use Change and Forestry (excluding combustion)	Grounds Maintenance	Gardening	IN
		Tree-cutting	IN
		Grass-cutting	IN
	Building Works	Building construction/extension	IN
		Building demolition	IN
	CO_2 Removals	Planting	IN
		Soils	IN
Indirect Emissions from Imported Electricity Consumed	Use of mains Electrical Equipment	Audio-visual Equipment	IN
		Lighting	IN
		Digital imaging equipment	IN
		MFD printer	IN
		White goods i.e. kettle, refrigerator, microwave	IN
		Water cooler	IN
		Computers and peripherals	IN
		Laboratory equipment, portable and stationary	IN
		Telecommunications	IN
		Electronic security and fire safety systems	IN
		Elevators	IN
		Automatic doors	IN
	Use of Rechargeable Battery Powered Equipment	Charging of laptops	IN
		Charging of tablets/mp3/mobile phones	IN
		Cordless power tools	IN
		Electric vehicles	IN
Indirect emissions from consumed energy through a physical network	Use of hot water	Wash facilities	IN
		Heating	IN
	Use of steam	Heating	IN
Energy-related Activities not Included in Direct Emissions and Energy Indirect Emissions	Use of Fuels	Extraction of consumed fuels	IN
		Production of consumed fuels	IN
		Transport of consumed fuels	IN
	Use of Electricity	Extraction of fuels consumed in generation of consumed electricity	IN
		Production of fuels consumed in generation of consumed electricity	IN
		Transport of fuels consumed in generation of consumed electricity	IN
		Transmission and distribution	IN
Purchased Products	The Arts, Audio-Visual &Multimedia Supplies and Services		OUT
	Library-related supplies and services		OUT
	Catering Supplies & Services		OUT
	Medical, Surgical, Nursing Supplies & Services		OUT
	Agricultural/Fisheries/Forestry/Horticultural/Oceanographic Supplies & Services		OUT
	Furniture, Furnishings & textiles		OUT
	Janitorial & Domestic Supplies		OUT
	Utilities		OUT
	Computer Supplies & Services		OUT
	Laboratory/Animal House Supplies & Services		OUT
	Workshop & Maintenance Supplies (Lab & Estates)		OUT
	Printing		OUT
	Telecommunications		OUT
	Stationery & Office Supplies		OUT
	Safety and Security		OUT
	Vehicles		OUT
	Estates & Buildings		OUT
	Miscellaneous		OUT
Capital Equipment	Fixed Assets	Server and related items	OUT

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Table B.1 (*continued*)

ISO Designation	Description	Site-specific Activity	Treatment
		Network Equipment Installation	OUT
		Telephony/Switchboard Cap Ex >£10,000	OUT
		Vehicle Purchase	OUT
		Portable and Laptop Computer Purchase	OUT
		Agricultural, Fisheries, Forestry, Oceanographic Capital Equipment >£10 k	OUT
Waste Generated from Organisational Activities	Generation of WEEE		IN
	Generation of food waste		IN
	Generation of recylate		IN
	Generation of wastewater	Sewerage	IN
	Generation of general refuse		IN
	Generation of hazardous waste	Clinical and Chemical laboratories	IN
	Generation of confidential waste	Accounts, student exam papers	IN
Upstream Transport and Distribution	Transport of Purchased Products	As per categories designated in 'purchased products'	OUT
	Services, repairs and maintenance of purchased products	As per categories designated in 'purchased products'	OUT
	Storage and movement of purchased products	Storage & Warehouse Services	OUT
		Archival Services	OUT
	Mail Services	Mail Services Overseas/International	OUT
		Freight, Carriage & Haulage Services	OUT
		Courier Services	OUT
	Waste	Waste consignments	OUT
Business Travel	Air travel	Attendance of international conferences	OUT
		Attendance of domestic conferences	OUT
		Attendance of meetings	OUT
		Outreach activities	OUT
		Field Trips	OUT
		Fieldwork	OUT
		Consultancy services	OUT
	Ferry travel	As per categories designated in 'air travel'	OUT
	Taxi hire		OUT
	Rail travel		OUT
	Mileage (Grey Fleet)		IN
	Car hire		OUT
	Van hire		OUT
	Coach hire		OUT
	Boat hire and charter		OUT
	Hospitality		OUT
Upstream Leased Assets	Hired Products	As per categories designated in 'purchased products'	OUT
	Building/Premises/Land - Rent, Lease, Hire, Feu Duties		OUT
Investments	Unique to reporting HEI		IN
Client and Visitor Transport	Air travel	Attendance of on-site conferences	OUT
		Attendance of meetings	OUT
		Outreach activities	OUT
		Visiting academics	OUT
		Consultancy services	OUT
	Ferry travel	As per categories designated in 'air travel'	OUT
	Taxi hire		OUT
	Rail travel		OUT
	Mileage (private vehicle use)		OUT
	Car hire		OUT
	Van hire		OUT
	Coach hire		OUT
Downstream Transport and Distribution	Not applicable to the HE sector		OUT
Use Stage of the Product	Not applicable to the HE sector		OUT
End of Life of the Product	Not applicable to the HE sector		OUT
Downstream Franchises	Not applicable to the HE sector		OUT
Downstream Leased Assets	Leased Products	As per categories designated in 'purchased products'	IN
	Building/Premises/Land - Rent, Lease, Hire, Feu Duties		IN
Employee Commuting	Air travel	Staff commuting	OUT
		Student commuting	OUT
	Ferry travel	Staff commuting	OUT
		Student commuting	OUT
	Taxi travel	Staff commuting	OUT
		Student commuting	OUT
	Rail travel	Staff commuting	OUT
		Student commuting	OUT
	Car travel	Staff commuting	IN
		Student commuting	IN

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Appendix B. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.jclepro.2017.02.147.

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