A Worthy Investment? Evaluating the Utility of Carbon Footprints for Informing Environmental Policy Within Organisations

MSc Sustainability (Climate Change) Dissertation

James Townsend supervised by Professor John Barrett
SOEE 5020

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Name: ____________________________

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Date: ____________________________

Course: __________________________
Abstract

Theoretically carbon footprints are of great relevance to environmental policy. This relevance however is at risk from the methodological inconsistencies prevalent within current research which render results inaccurate or incomparable. Rectifying this situation could benefit sustainable procurement, though whether carbon footprints results can guide procurement decisions that are practical in reality has remained largely untested.

This study addresses these methodological and practicality issues using the University of Leeds as a case study. Utilising input-output analysis, the carbon footprint for the university was derived as 161,819t CO2e for the year 2010/11. Scope 3 emissions were dominant, comprising 51% of emissions. A benchmarking analysis suggested that Scope 3 emissions were likely underestimated owing to the narrower organisational boundary that was employed compared to other studies. This was particularly apparent for transport emissions where emissions from commuting were not considered, and for electricity life cycle emissions where energy use at private halls of residence was not considered. This highlights the imperative of defining standardised organisational boundaries that must be adhered to when deriving the carbon footprint for organisations. Standardised emissions categories are also required to allow for efficient comparisons of environmental performance across organisations.

Despite these methodological deficiencies constraining benchmarking, carbon footprints were found to effectively supplement sustainable procurement strategies. Interviews with university procurement staff revealed that the quantitative nature of the results was highly beneficial. These benefits manifested from the identification of emissions hotspots within the university supply chain which could subsequently be prioritised in mitigation efforts. The ability to direct mitigation efforts to areas that may entail financial savings was particularly attractive, especially amidst budgetary constraints which traditionally restrict sustainable procurement procedures.

Some purchasing areas such as transport were adverse to change regardless of whether they were identified as an emissions hotspot owing to limited mobility within the university policy environment. Further, a more detailed application of carbon footprints beyond the identification of emissions hotspots was constrained by the aggregation issues within input-output analysis, which, on occasions, meant that certain goods and services inducing emissions could not be identified explicitly and targeted for mitigation efforts.

Despite these limitations the utility of carbon footprints for informing sustainable procurement was undoubted, with the awareness-raising potential of results entailing a further benefit that can elevate environmental issues in the conscious of individuals.
Acknowledgements

There are a number of people to whom I owe sincere thanks since without their help this project would not have been possible. My supervisor, Professor John Barrett, provided invaluable support and without his infectious enthusiasm the process would have been much more difficult. I am grateful to James Dixon-Gough for his guidance and also his coordinating efforts which meant I was able to conduct this project in the first place. I owe large thanks to Adele White and especially Richard Lewis who fulfilled my data requirements. I am indebted to all the interview respondents who took time out of their schedules to assist this project, and to Phil Longton and Steve Winter who provided vital bits of information. Finally I wish to express my thanks to my family and friends for their incredible support and spurring me on throughout the process.
Table of Contents

List of Figures ......................................................................................................................................... 6
List of Tables .......................................................................................................................................... 7
List of Abbreviations .............................................................................................................................. 8

1) Introduction .................................................................................................................................. 9
   1.1) The Rise of Consumption-Based Carbon Footprinting ........................................................... 9
   1.2) Carbon Footprinting within Higher Education ..................................................................... 10
   1.3) Carbon Footprints and Sustainable Procurement – An Odd Couple? ................................. 10
   1.4) Aims and Objectives ............................................................................................................. 11

2) Literature Review ............................................................................................................................... 12
   2.1) Carbon Footprint Methodologies ...................................................................................... 12
       2.1.2) Evaluation of Process Analysis ................................................................. 12
       2.1.3) Evaluation of Input-Output Analysis ........................................................................ 13
       2.1.4) Overview of Hybrid Life Cycle Assessment .................................................... 13
   2.2) Appraisal of Carbon Footprint Research within the Services Sector ............................... 14
       2.2.1) Composition of the Carbon Footprints ...................................................... 14
       2.2.2) Analysis of the Scope 3 Components .......................................................... 16
   2.3) The Utility of Carbon Footprints for Informing Sustainable Procurement ....................... 17
       2.3.1) The Functionality of Carbon Footprints for Informing Sustainable Procurement ... 18
       2.3.2) Practical Issues within Sustainable Procurement ........................................... 19

3) Methodology ....................................................................................................................................... 22
   3.1) Estimating the Carbon Footprint ....................................................................................... 22
       3.1.1) Scope 1 and Scope 2 Emissions .............................................................................. 22
       3.1.2) Scope 3 Emissions ................................................................................................. 22
   3.3) Assessing the Utility of Carbon Footprint Results for Informing Sustainable Procurement 25
       3.3.1) Semi-Structured Interviews ............................................................................... 25
       3.3.2) Sampling Strategy ............................................................................................... 26
       3.3.3) Analysis ................................................................................................................ 26
       3.3.4) Limitations ............................................................................................................ 26

4) Results ......................................................................................................................................... 27
   4.1) Carbon Footprint Results ..................................................................................................... 27
       4.1.1) University-Level ................................................................................................. 27
A Worthy Investment? Evaluating the Utility of Carbon Footprints for Informing Environmental Policy Within Organisations

4.1.2) Department-Level

4.2) Interview Results

4.2.1) The Functionality of Carbon Footprint Results

4.2.2) The Practicality of Implementing Changes within Procurement

5) Discussion

5.1) Benchmarking the University of Leeds’ Carbon Footprint

5.1.1) Overarching Composition

5.1.2) Scope 3 Components

5.2) Evaluating the Utility of Carbon Footprints for Informing Sustainable Procurement

5.2.1) Carbon Footprints as a Screening Tool

5.2.2) Carbon Footprints as a Detailed Analytical Tool

5.2.3) Wider Practicality Issues

6) Conclusion

7) References

8) Appendix

A. Scope 1 and Scope 2 Emissions Data

B. Composition of Scope 3 Broad Product Categories

C. Interview Agenda

D. Coding structure

E. GHG impacts of detailed commodity groups
List of Figures

Figure 3.1. Basic steps of input-output analysis (Adapted from Hendrickson et al., 2006; pp.13)...........23

Figure 4.1. Breakdown of the University of Leeds’ Carbon Footprint according to the GHG Protocol Scopes and Scope 3 broad product categories.................................................................27

Figure 4.2. Emissions from Scope 3 broad product categories in both absolute and intensity terms...29

Figure 4.3. Impacts of Scope 3 broad product categories in terms of both emissions and expenditure.................................................................................................................................29

Figure 4.4. Emissions from Manufactured Products’ commodity groups in both absolute and intensity terms........................................................................................................................................30

Figure 4.5. Impacts of Manufactured Products’ commodity groups in terms of both emissions and expenditure.........................................................................................................................................30

Figure 4.6. Emissions from Machinery and Computers’ commodity groups in both absolute and intensity terms.......................................................................................................................................31

Figure 4.7. Impacts of Machinery and Computers’ commodity groups in terms of both emissions and expenditure.........................................................................................................................................31

Figure 4.8. Emission from Utilities and Construction’ commodity groups in both absolute and intensity terms..........................................................................................................................................32

Figure 4.9. Impacts of Utilities and Constructions’ commodity groups in terms of both emissions and expenditure.........................................................................................................................................32

Figure 4.10. Emissions from Transport and Communications’ commodity groups in both absolute and intensity terms........................................................................................................................................33

Figure 4.11. Impacts of Transport and Communications’ commodity groups in terms of both emissions and expenditure.........................................................................................................................................33

Figure 4.12. Emissions from Public Services’ commodity groups in both absolute and intensity terms...........................................................................................................................................34

Figure 4.13. Impacts of Public Services’ commodity groups in terms of both emissions and expenditure...........................................................................................................................................34
A Worthy Investment? Evaluating the Utility of Carbon Footprints for Informing Environmental Policy Within Organisations

Figure 4.14. Departmental carbon footprints…………………………………………………………..36

Figure 4.15. Departmental emissions in both absolute and intensity terms………………………….37

Figure 4.16. Impacts of departments in terms of both emissions and expenditure. ………………………..37

Figure 5.1. The emissions of Higher Education institutions in absolute terms and intensity terms….43

**List of Tables**

Table 2.1. Overview of Carbon Footprint studies…………………………………………………….15

Table 2.2. Case studies entailing collaboration between academics and practitioners in carbon footprinting……………………………………………………………………………………….18

Table 3.1. Scope of Scope 3 Analysis (Adapted from WRI and WBCSD, 2011; pp. 34-35)………………..24

Table 3.2. Details of interview respondents…………………………………………………………..25

Table 8.1. Scope 1 and Scope 2 data measured directly for the University of Leeds…………………..59

Tables 8.2 a, b and c. Composition of broad product categories…………………………………60-61

Table 8.3. Coding structure from interview data………………………………………………………63

Tables 8.4 a, b and c. GHG impacts of commodity groups……………………………………………..64-65
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>CF</td>
<td>Carbon footprint</td>
</tr>
<tr>
<td>DMU</td>
<td>De Montfort University</td>
</tr>
<tr>
<td>ESSL</td>
<td>Faculty of Education, Social Sciences &amp; Law</td>
</tr>
<tr>
<td>GHG</td>
<td>Greenhouse gas</td>
</tr>
<tr>
<td>HE</td>
<td>Higher education</td>
</tr>
<tr>
<td>HEFCE</td>
<td>Higher Education Funding Council for England</td>
</tr>
<tr>
<td>HLCA</td>
<td>Hybrid life cycle assessment</td>
</tr>
<tr>
<td>HMRC</td>
<td>Her Majesty’s Revenue and Customs</td>
</tr>
<tr>
<td>IOA</td>
<td>Input-output analysis</td>
</tr>
<tr>
<td>LU</td>
<td>Lancaster University</td>
</tr>
<tr>
<td>LUBS</td>
<td>Leeds University Business School</td>
</tr>
<tr>
<td>MAPs</td>
<td>Mathematics and Physical Sciences</td>
</tr>
<tr>
<td>NHS</td>
<td>National Health Service</td>
</tr>
<tr>
<td>NTNU</td>
<td>the Norwegian University of Technology &amp; Science</td>
</tr>
<tr>
<td>PA</td>
<td>Process analysis</td>
</tr>
<tr>
<td>P, VA &amp; C</td>
<td>Performance, Visual Arts &amp; Communication</td>
</tr>
<tr>
<td>SP</td>
<td>Sustainable procurement</td>
</tr>
<tr>
<td>SPA</td>
<td>Structural path analysis</td>
</tr>
<tr>
<td>UCT</td>
<td>the University of Cape Town</td>
</tr>
<tr>
<td>UIC</td>
<td>the University of Illinois, Chicago</td>
</tr>
<tr>
<td>UoL</td>
<td>the University of Leeds</td>
</tr>
<tr>
<td>YU</td>
<td>Yale University</td>
</tr>
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1) Introduction

1.1) The Rise of Consumption-Based Carbon Footprinting

With the consequences of climate change becoming more pronounced, organisations are becoming increasingly conscious of their climate impacts (Huang et al., 2009a). This has provoked many organisations to measure the greenhouse gas (GHG) emissions that accrue from their activities; such practice is known as carbon footprinting (Huang et al., 2009a; Wiedmann, 2009; Peters, 2010).

International standards, the most widely used of which are the GHG Protocol variants (WRI and WBCSD, 2004; 2011), provide guidance for organisations on how to measure their carbon footprint (CF). The GHG Protocol divides emissions into three “Scopes”:

- Scope 1: Emissions accruing from sources owned or controlled by the organisation
- Scope 2: Emissions from the generation of electricity consumed by the company
- Scope 3: Indirect emissions that are associated with the activities of an organisation, but accrue in the supply chain from sources that are not owned or controlled by the organisation

Scope 3 emissions have traditionally been neglected in organisational CFs, which have tended to appraise just Scope 1 and Scope 2 emissions (Matthews et al., 2008; Huang et al., 2009a; Wiedmann and Barrett, 2011). This reflects a production-based approach, whereby focus is directed towards emissions sources that the organisation has direct control over (Larsen and Hertwich, 2009; Baboulet and Lenz, 2010).

The validity of production-based carbon footprinting is being fiercely challenged amidst the realisation that the largest emission sources usually reside in the upstream paths of supply chains (Huang et al., 2009b). This is especially true for organisations within the services sector, which despite producing a limited amount of emissions directly, foster considerable amounts indirectly (Suh, 2006; Nansai et al., 2007; Minx et al., 2009a).

As such, a CF is not robust unless it incorporates all three Scopes (Matthews et al., 2008; Minx et al., 2009b; Peters, 2010). This is internalised in the consumption-based approach to carbon footprinting, where the CF is defined as “a measure of the total amount of carbon dioxide emissions that is directly and indirectly caused by an activity or is accumulated over the life stages of a product” (Wiedmann and Minx, 2008; pp. 4).

Consumption-based CFs have been derived for: corporations (Wiedmann et al., 2009; Berners-Lee et al., 2011), municipalities (Larsen and Hertwich, 2009; 2011), government (Wiedmann and Barrett, 2010; 2011), and public institutions (GAP et al., 2006; SDC et al., 2008), and all affirm the importance of Scope 3 emissions.
1.2) Carbon Footprinting within Higher Education

Higher Education (HE) is commonly regarded as a role model for the sustainable use of resources and the protection of the environment (Viebahn, 2002; Lozano, 2010; Stephens and Graham, 2010). Despite this, CF research within the HE sector is rather fragmented.

Although a number of studies have derived the consumption-based CFs of universities (Klein-Banai et al., 2010; Letete et al., 2011; Thurston and Eckelman, 2011; Lancaster University, 2012a; Larsen et al., In press; Ozawa-Meida et al., In press), methodological inconsistencies prevent competent comparisons across cases and resolve dubious results where Scope 3 emissions have not been adequately accounted for.

This situation could soon be rectified since The Higher Education Funding Council for England (HEFCE) is mandating all English universities to report their Scope 3 emissions from December 2012 (HEFCE, 2010). This regulation could facilitate greater flexibility in carbon management as an estimation of Scope 3 emissions allows mitigation efforts to enter the supply chain as a potential alternative to expensive on-site measures (Matthews et al., 2008; Wiedmann et al., 2009).

Mitigation efforts involving the supply chain resonate with sustainable procurement (SP). SP is “the pursuit of sustainable development objectives through the purchasing and supply process” (Walker et al., 2010; pp. 150). It encompasses concerns for the environmental, economic and social aspects of procurement decisions (Brammer and Walker, 2011; Oruezabala and Rico, 2012), but this paper engages with just the environmental aspect. This is reasonable since carbon management is an environmental pursuit and SP itself has strong environmental traditions (Seurling and Muller, 2008; Brammer and Walker, 2011; Sarkis et al., 2011). Accordingly, in this paper SP is seen to entail actions such as purchasing from environmentally responsible suppliers, and using purchasing power to influence product packaging and transport (Srivastava, 2007).

1.3) Carbon Footprints and Sustainable Procurement – An Odd Couple?

At the surface, using CFs to inform SP appears a no-brainer. SP requires a tool that can provide quantitative information so the environmental impacts accumulating within complex supply chains can be better understood (Sundarakani et al., 2010; Walker et al., 2010; Young et al., 2010), a requirement that consumption-based CFs theoretically can fulfil. For instance, they can identify upstream emissions hotspots where mitigation efforts can be prioritised (Larsen and Hertwich, 2009; Minx et al., 2009b; Wiedmann et al., 2009), and can track the progress of SP policies over time (Minx et al., 2009a; b; Ozawa-Meida et al., In press).

However, academics and practitioners exist largely isolated from each other in the field of carbon footprinting, with the resultant knowledge-gap preventing practitioners from applying academically-derived tools and information (Wiedmann, 2009; Ascui and Lovell, In press; Burritt and Tingey-
Holyoak, In press). Increased collaboration between parties entails a potential route to abate this isolation and facilitate the transfer of knowledge to practitioners (Wiedmann, 2009; Ascui et al., In press; Burritt and Tingey-Holyoak, In press).

A number of studies have deployed such collaboration (Larsen and Hertwich, 2010b; Berners-Lee et al., 2011; Ozawa-Meida et al., In press) and provide evidence that CFs can fulfil their potential for informing SP. However, the studies lack transparency as to the extent of the collaboration, and, perhaps most importantly, they fail to engage with the practical issues within SP such as the potential cultural resistance to change (Young et al., 2010; Ageron et al., In press; Hoejmose and Adrien-Kirby, In press), and cost issues (Min and Galle, 2001; Testa and Iraldo, 2010; Brammer and Walker, 2011).

These issues have the potency to constrain changes in procurement strategies, and could potentially devalue CF results should suggested mitigation routes be impractical. Thus, conclusions regarding the utility of CFs for informing SP are currently tentative, with no robust evidence available that addresses the problem in its context.

1.4) Aims and Objectives

The aims of this paper are as follows:

- To quantify the consumption-based CF for the University of Leeds (UoL)
  To achieve this, input-output analysis (IOA) will be utilised to derive the CF. The analysis will be driven by departmental expenditure data which will be summed to attain the CF for the university.

- To contribute to the defragmentation of CF research in the HE sector by identifying and scrutinising the main methodological discrepancies within the field.
  This will be fulfilled by benchmarking CF results for the UoL against other CFs from the services sector. Where large discrepancies exist between results for particular procurement areas, these areas will be evaluated to assess whether the discrepancies arise due to methodological differences.

- To evaluate the utility of CFs for informing SP decisions in a manner that is conscious to the practical realities of SP.
  This will be achieved by presenting CF results to university procurement staff and subsequently interviewing them regarding the utility of the results for informing SP. Interview data will be compared across respondents to identify recurrent themes from which the utility of CFs can be evaluated.

This paper is structured as follows: Section 2 reviews relevant literature; Section 3 outlines the employed methodology; Section 4 presents the results which are subsequently appraised with reference to literature in Section 5; Section 6 encompasses concluding remarks.
2) Literature Review

This section proceeds as follows: Section 2.1 outlines the available methodologies for deriving consumption-based CFs; Section 2.2 appraises CF research within the services sector; Section 2.3 outlines the current situation regarding the utility of CF results for informing SP.

2.1) Carbon Footprint Methodologies

A consumption-based CF should encompass all the GHG emissions that are associated directly and indirectly with organisational activity (Wiedmann and Minx, 2008; Wiedmann, 2009). This necessitates the characterisation of the environmental impacts of goods or services throughout their entire life cycle; incorporating upstream emissions from the extraction of raw materials through manufacturing, and downstream emissions through the use and end-of-life phases (Wiedmann, 2009; Williams et al., 2009; Peters, 2010).

The life cycle-wide impacts of organisations have been addressed through two methods: process analysis (PA) and IOA. PA is based on a bottom-up model of a supply chain, with constituent processes described in terms of material inputs and environmentally significant outputs (Williams et al., 2009). IOA is a top-down economic technique that uses sectoral monetary transactions to account for the complex interdependencies of industries in modern economies (Lenzen, 2001a). Each method is best suited to particular types of enquiries, being distinct in their depth and width of analysis (Bullard et al., 1978; Wiedmann et al., 2009).

The main strengths and limitations of PA are appraised in Section 2.1.2, whilst IOA is considered in Section 2.1.3. A brief overview of hybrid life cycle assessment (HLCA) that combines the strengths of PA and IOA is given in Section 2.1.4.

2.1.2) Evaluation of Process Analysis

The major strength of PA is that it can produce results to a high level of precision (Wiedmann, 2009). This results from the collection of specific primary and secondary data at the relevant process level (Minx et al., 2008). Such precision makes PA applicable for measuring the CF of microsystems and for informing process improvement and product design (Minx et al., 2008; Wiedmann et al., 2009).

The most significant limitation within PA is the cut-off error (Lenzen, 2001a; Minx et al., 2008). This relates to the systematic underestimation of environmental impacts caused by the exclusion of particular inputs or outputs from the organisational system (Williams et al., 2009). It arises since whilst the main emissions outputs and some important inputs into the main processes are considered in detail, a system boundary is delimited under the assumption that the addition of successive upstream paths will have a small effect on the total CF (Lenzen, 2001a).
The location of the cut-off is based on time and data availability, and is always a subjective decision (Suh et al., 2004; Williams et al., 2009). Consequently, the extent of the cut-off error is always unknown, though IOA studies suggest system completeness is typically around 50% (Lenzen, 2001a; Lenzen and Treloar, 2003; Crawford, 2008). This can lead to misleading conclusions regarding an organisation’s CF (Lenzen, 2001a; Lenzen and Treloar, 2003).

2.1.3) Evaluation of Input-Output Analysis

An economy-wide approach, IOA inherently covers all upstream paths in the supply chain, thus eliminating cut-off error (Lenzen, 2001a; Wiedmann, 2009). Accordingly, it is appropriate for measuring the CF of mesosystems and macrosystems such as organisations and countries (Wiedmann, 2009; Wiedmann et al., 2009). Its application is especially favourable for public activities as it includes many non-physical flows such as services (Larsen and Hertwich, 2009).

The primary limitations of IOA are associated with its high level aggregation (Suh and Nakamura, 2007; Minx et al., 2008). This error results from the aggregation of numerous facilities and commodities into single sectors in input-output tables, (Lenzen, 2001a; Suh and Huppes, 2005; Williams et al., 2009). Goods and services are thus assumed to be typical of their respective sector’s output, diluting industrial diversity and product diversity (Bullard et al., 1978; Lenzen, 2001a). In a similar vein, significant error is induced within single-region input output models that assume foreign industries are homogenous to domestic industries regarding the production of goods (Lenzen, 2001a; Suh et al., 2004; Minx et al., 2008).

IOA also fails to represent the use and end-of-life phases, thus neglecting downstream emissions (Lenzen, 2001a; Suh and Huppes, 2005; Minx et al., 2008). However, the impacts of the end-of-life stages are often negligible (Lenzen, 2011a).

Uncertainties in source data, estimation uncertainty for capital commodities, and the assumption of proportionality between monetary and physical flow of commodities constitute additional sources of uncertainty (see Lenzen, 2001a; Suh and Nakamura, 2007; Williams et al., 2009).

2.1.4) Overview of Hybrid Life Cycle Assessment

HLCA combines PA and IOA, using the strengths of each method to overcome its counterpart’s limitations (Lenzen, 2001a; Minx et al., 2008). IOA provides information for goods or processes that are well represented in input-output tables, and ensures coverage of the complete system (Suh et al., 2004; Minx et al., 2008). For the main inputs and outputs, aggregated input-output data is substituted for more detailed process data until a desired level of accuracy is achieved in the CF (Suh et al., 2004; Suh and Huppes, 2005; Minx et al., 2008).
This increased detail comes at the expense of time and complexity (Lenzen, 2001a). HCLA poses the question of where the boundary between the process system and the input-out system should be located, since modelling minimal processes will return results similar to those obtainable from IOA (Suh et al., 2004; Minx et al., 2008). This issue can be resolved by implementing structural path analysis (SPA), a technique which provides a preliminary ranking of the most important input paths which can subsequently be prioritised for PA (Treloar, 1997; Lenzen, 2002).

### 2.2) Appraisal of Carbon Footprint Research within the Services Sector

Although greater than 75% of an industry’s CF is attributable to Scope 3 sources on average, an organisation’s Scope 3 profile is often unique (Matthews et al., 2008; Huang et al., 2009a). Despite this, reasonable comparisons can be made between the CFs of organisations that exist within the same sector (Huang et al., 2009a).

Such intra-sectoral comparisons are necessary for broadening analysis given that CF research is still in its infancy (Owaza-Meida et al., In press). Thus, as well as appraising CF research conducted within the HE sector, studies from the wider services sector are appraised. The results of relevant studies are displayed in Table 2.1.

The overarching compositions of the CFs within Table 2.1 are evaluated in Section 2.2.1, whilst their Scope 3 emissions sources are scrutinised in Section 2.2.2.

#### 2.2.1) Composition of the Carbon Footprints

Scope 3 emissions clearly dominate the CFs across studies. This is to be expected since whilst services produce minimal emissions directly, their activities require manufactured goods, transport and electricity which induces a significant amount of emissions indirectly (Suh, 2006; Nansai et al., 2007; Minx et al., 2009a).

Where this trend is not apparent for UIC and UCT, this is owing to the application of PA. Klein-Banai et al. (2010) and Letete et al. (2011) both considered only waste and transport as Scope 3 emissions sources, therefore provoking considerable cut-off error in results (Lenzen, 2001a; Minx et al., 2008; Williams et al., 2009). As such, the CFs for UIC and UCT are not robust, and will not be considered further.

LU is notable since although Scope 3 emissions dominate its CF, this occurs at a lesser extent than for other studies. This is not due to methodological deficiencies, but is a reflection of outdated energy infrastructure within the institution (Lancaster University and ARUP, 2007). This makes direct energy consumption a greater issue than for other studies.
Table 2.1. Overview of Carbon Footprint studies

<table>
<thead>
<tr>
<th>Reference</th>
<th>Sector</th>
<th>Case study</th>
<th>Method</th>
<th>Carbon footprint (t CO2e)</th>
<th>Carbon footprint (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Ozawa-Meida et al., In press)</td>
<td>HE</td>
<td>De Montfort University (DMU)</td>
<td>HLCA</td>
<td>51,080</td>
<td>6 15 79</td>
</tr>
<tr>
<td>(Lancaster University, 2012a)</td>
<td>HE</td>
<td>Lancaster University (LU)</td>
<td></td>
<td>71,700</td>
<td>21 23 56</td>
</tr>
<tr>
<td>(Thurston and Eckelman, 2011)</td>
<td>HE</td>
<td>Yale University (YU)</td>
<td></td>
<td>874,000</td>
<td>19 5 76</td>
</tr>
<tr>
<td>(Larsen et al., In press)</td>
<td>HE</td>
<td>The Norwegian University of Technology &amp; Science (NTNU)</td>
<td>IOA</td>
<td>92,100</td>
<td>20 80</td>
</tr>
<tr>
<td>(Klein-Banai et al., 2010)</td>
<td>HE</td>
<td>The University of Illinois, Chicago (UIC)</td>
<td>PA</td>
<td>275,000</td>
<td>64 17 19</td>
</tr>
<tr>
<td>(Letete et al., 2011)</td>
<td>HE</td>
<td>The University of Cape Town (UCT)</td>
<td></td>
<td>84,926</td>
<td>81 19</td>
</tr>
<tr>
<td>Wiedmann and Barrett, 2010; 2011)</td>
<td>Wider services</td>
<td>UK Central Government</td>
<td>IOA</td>
<td>64,700,000</td>
<td>13 10 77</td>
</tr>
<tr>
<td>(Larsen and Hertwich, 2011)</td>
<td>Wider services</td>
<td>Sogn og Fjordane (Norwegian county)</td>
<td></td>
<td>56,775</td>
<td>1 5 94</td>
</tr>
<tr>
<td>(Larsen and Hertwich, 2009)</td>
<td>Wider services</td>
<td>Trondheim (Norwegian city)</td>
<td></td>
<td>~94,000</td>
<td>7 8 85</td>
</tr>
<tr>
<td>(GAP et al., 2006)</td>
<td>Wider services</td>
<td>UK Schools</td>
<td>HLCA</td>
<td>10,500,000</td>
<td>26 74</td>
</tr>
<tr>
<td>(SDC et al., 2008)</td>
<td>Wider services</td>
<td>The National Health Service (NHS)</td>
<td></td>
<td>18,610,000</td>
<td>14 12 74</td>
</tr>
</tbody>
</table>
2.2.2) Analysis of the Scope 3 Components

Construction is a major contributor to most of the CFs, particularly in the HE sector. For both DMU and NTNU, construction contributes around 20% of the total CF, whilst at YU it contributes an even greater 26%.

Transport emissions are also significant across studies, though their magnitude and the activities from which they originate tend to vary. They comprise 29% of the CF at DMU and LU, commuting being the main contributor in both cases, making up 18% and 16% of emissions respectively. Business travel induced the remaining 13% of emissions at LU, but made up only 2% of emissions at DMU where students’ trips from home to university was the next major contributor after commuting (8%).

At NTNU transport emissions make up 16% of the CF. However, it is not possible to attribute these emissions to particular activities due to a lack of transparency in transport sub-categories. For instance, employees’ travels could relate to either staff commutes or business travel. Similar issues are prevalent at YU where transport emissions make up 8% of the CF. As such, these figures should be treated with caution because it is unclear which transport sub-categories are included in the CFs. This documents the imperative of defining a universal organisational boundary to ensure that emissions categories are consistent across CFs and to allow for more efficient benchmarking (Weidema et al., 2008; Ozawa-Meida et al., In press).

Electricity life cycle emissions (the supply chain impacts of electricity generation [Wiedmann and Barrett, 2011]) also falter with regards to inconsistent organisational boundaries. At DMU energy use from private halls of residence was considered explicitly within the CF and contributed 9% of emissions. Conversely, at NTNU electricity life cycle emissions were almost negligible. Such a situation is plausible since electricity life cycle emissions also had a minimal impact for the UK Government. However, this situation may have also arisen due to a limited scope of analysis, with emissions from energy use at private halls of residence appearing neglected from the NTNU CF.

Machinery and computers are consistent within organisational boundaries across studies, but simply comprise a variable emissions source. They contribute almost 19% of the CF at NTNU, but only 3% at DMU where they had the same impacts as manufactured products.

Manufactured products were not analysed specifically at NTNU, instead they were aggregated into a wider consumables category containing food and books. In a similar fashion, machinery is considered within the manufactured products category at DMU, whilst manufactured products were aggregated with machinery, paper and chemicals in UK Schools. The subjectivity of aggregation compounds the issue of inconsistent system boundaries, further constraining effective benchmarking.
Business services make up 5% and 9% of the CF for NTNU and DMU respectively. Emissions from public services are of lesser significance however, forming just 1% and 2% of emissions respectively; this mainly from training courses and teaching services for both institutions.

For Sogn og Fjordane and Trodheim the pattern is reversed. Whilst business services contribute around 3% and 2% in Sogn og Fjordane and Trodheim of emissions respectively, public services contribute 47% and 5%. The provision of public transport makes public services emissions anomalously large at Sogn og Fjordane, whilst at Trodheim they accumulate mainly from waste disposal.

A number of categories made consistently minor contributions to the CFs across studies. For: DMU, NTNU, YU, Sogn og Fjordane and UK schools, food and catering contributed around 1% of the total emissions.

Similarly, chemicals contributed 1% of the CF for: DMU, NTNU and YU. The NHS was anomalous with regards to chemicals, with them comprising 24% of the CF, 21% of this from pharmaceuticals. This is attributable to the NHS’s specialist function as a health service.

Paper also made only a minor contribution, forming 1% of the CF for both DMU and NTNU.

2.3) The Utility of Carbon Footprints for Informing Sustainable Procurement

Within academia, CFs are acclaimed for harnessing great potential for informing policy-making (Huang et al., 2009b; Peters, 2010). One key policy domain that can be supplemented with CF results is SP. The provision of quantitative evidence for informing SP policies is not only a necessity, but an imperative given the complexity of modern supply chains (Sundarakani et al., 2010; Young et al., 2010).

Despite the broad appeal of CFs however (Weidema et al., 2008), a common grounding between academics and practitioners regarding the concept is far from prevalent (Ascui et al., In press; Burritt and Tingey-Holyoak, In press). Instead, isolation exists between the parties and an associated knowledge-gap has prevented the diffusion of academically-derived techniques capable of informing SP from entering the practitioner’s toolbox (Ascui et al., In press).

This situation has culminated as a result of two factors, the first being the unfamiliar nature of IOA, the predominant method for deriving organisational CFs, amongst the majority of practitioners (Foran et al., 2005; Huang et al., 2009b; Minx et al., 2009b; Wiedmann, 2009). The second reason relates to the uncertainties within IOA which leaves practitioners doubting the validity of CF results (Huang et al., 2009b; Wiedmann, 2009; Berners-Lee et al., 2011).

Increased collaboration is key for overcoming these factors and facilitating the transfer of knowledge to practitioners to enable the utilisation of CFs for guiding SP decisions (Wiedmann, 2009; Baoulet...
and Lenzen, 2010; Burritt and Tingey-Holyoak, In press). To be successful collaboration has to entail a mutual recognition of the respective competences of both academics and practitioners, whilst all interaction between parties should be deliberate (Ascuí et al., In press). The option of deploying HCLA also exists if practitioners are more likely to act on results at a level of accuracy unobtainable from IOA (Berners-Lee et al., 2011).

Two central issues regarding the utility of CF results for informing SP are covered in this section. Section 2.3.1 explores the functionality of CF results, whilst Section 2.3.2 outlines the practicality issues that must be deliberated when considering changes in procurement strategies.

### 2.3.1) The Functionality of Carbon Footprints for Informing Sustainable Procurement

A number of studies (see Table 2.2) have been conducted where academics and practitioners have collaborated in the construction of CFs and the implementation of their results. This provides scope to assess whether the theoretical functions of CFs correspond with the functions they uptake in reality for informing environmental policy.

#### Table 2.2. Case studies entailing collaboration between academics and practitioners in carbon footprinting

<table>
<thead>
<tr>
<th>Reference</th>
<th>Case Study</th>
<th>Functions explored</th>
<th>Fulfilled in reality</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Ozawa-Meida., et al., In press)</td>
<td>De Montfort University (DMU)</td>
<td>Screening assessment</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Detailed analytical tool</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Awareness-raising</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Policy tracker</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Benchmarking tool</td>
<td>No</td>
</tr>
<tr>
<td>(Berners-Lee et al., 2011)</td>
<td>Small Cumbrian Tourism Business</td>
<td>Screening assessment</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Detailed analytical tool</td>
<td>Yes (for important inputs)</td>
</tr>
<tr>
<td>(Larsen and Hertwich, 2010b)</td>
<td>Tromso (Norwegian city)</td>
<td>Awareness-raising</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Policy tracker</td>
<td>Yes</td>
</tr>
</tbody>
</table>

At DMU CF results were used to identify the most significant emissions sources. This was mirrored by the tourism business, where the alignment of costs to emissions was deemed useful for identifying mitigation routes that harnessed potential financial savings.

This confirms that carbon footprinting can act as a screening process from which emissions hotspots can be identified and subsequently prioritised in mitigation efforts (Larsen and Hertwich, 2009; Minx et al., 2009b; Wiedmann et al., 2009). It also supports suggestions that CF results can resolve cost-efficient mitigation routes in the supply chain which would otherwise remain unbeknown to practitioners (Larsen and Hertwich, 2009; Wiedmann et al., 2009).

CFs were unable to provide an analytical basis for scrutinising detailed adaptations to procurement strategies (Larsen and Hertwich, 2009; Baboulet and Lenzen, 2010). This was apparent at DMU where the sector-average emissions factors in input-output tables were insufficient for reflecting...
detailed changes in procurement such as the replacement of virgin paper with recycled paper. This was less of an issue for the tourism business, which substituted the aggregated values within input-output tables for detailed process data so important inputs such as food could be differentiated by type accurately.

With reference to the diffusion of life cycle thinking within procurement procedures at DMU, awareness-raising of sustainability issues appears to be another function of CFs (Weidema et al., 2008). This function is reinforced in Tromso where CF results were utilised to raise awareness of the importance of Scope 3 emissions.

A further function of the CF in Tromso was to track the progress of emissions mitigation strategies. Similarly, at DMU the CF was used to measure the progress of newly implemented policies within the university’s carbon management plan.

This affirms that CFs fulfil their role as a policy tracker through time (Minx et al., 2009a; b; Wiedmann et al., 2009; Thurston and Eckelman, 2011). Constructing a time series is necessary here in order to capture spikes in an organisation’s performance (Wiedmann et al., 2009), invigorating the otherwise static data.

Benchmarking constitutes another potential function of CFs, allowing organisations to compare their environmental performance against their sectoral counterparts (Huang et al., 2009b; Wiedmann et al., 2009; Larsen and Hertwich, 2010b). At DMU this function was constrained by inconsistent organisational boundaries which meant it was impossible to deduce which emissions sources had been included in other organisations’ CFs.

Though the studies provide insights into the utility of CFs for informing SP, these are tentative at best since a lack of transparency obscures the nature of the interaction between academics and practitioners. Further, the studies are detached from the practical realities of SP, and without due consideration of such issues the policy relevance of carbon footprinting is fallible.

2.3.2) Practical Issues within Sustainable Procurement

2.3.2.1) Barriers to Change

Since organisations often operate with established ways of working (Foran et al., 2005), it can take a substantial amount of time and effort to implement changes against central inertia (Hakke and Seurling, 2009). This is associated with cultural resistance to change, which is often recognised as the biggest barrier to the implementation of SP (Young et al., 2010; Ageron et al., In press; Hoejmose and Adrien-Kirby, In press).
Cultural resistance can arise from staff adverse to either an increasingly challenging workload (Baboulet and Lenzen, 2010), or to potential disempowerment originating from the rearranging of procurement processes (Foran et al., 2005).

The reluctance of managers to engage with SP processes owing to the potential costs involved combined with uncertain benefits provides an additional source of resistance (Min and Galle, 2001; Brammer and Walker, 2011; Hoejmose and Adrien-Kirby, In press).

Despite suggestion of a mutualistic relationship between reducing emissions and reducing costs in the life cycle of goods (Porter and van der Linde, 1995), such a relationship is perhaps too simplistic, with it rarely transpiring from SP processes (Seurling and Muller, 2008; Testa and Iraldo, 2010; Oruezabala and Rico, 2012). There are occasions where a positive relationship has been observed between environmental performance and economic performance (e.g. Rao and Holt, 2005), although such occasions are the exception rather than the rule. Any benefits that arise from SP are most likely intangible, and thus resolve little financial gains in the short-run at least (Preuss, 2005; Testa and Iraldo, 2010; Ageron et al., In press).

Thus, owing to budget cuts and heightened coordination efforts and complexity (Seurling and Muller, 2008; Young et al., 2010; Oruezabala and Rico, 2012), the cheapest option normally takes priority over the environmental option in procurement (Michelson and de Boer, 2009; Baboulet and Lenzen, 2010). This is especially true within public institutions such as universities which have to converse money for a vast array of tasks (Preuss, 2007).

The viability of adapting procurement strategies and substituting goods and services for less polluting alternatives depends largely on the nature of the goods or services in question, and also on the procurement structure (Foran et al., 2005; Young et al., 2010). A central concern is that the quality of goods and services remain intact following the substitution (Bala et al., 2008; Berners-Lee et al., 2011). As such, whereas interventions in food, ICT, and paper and printing are plausible, this is less so considering other purchasing areas (Ozawa-Meida et al., In press).

One area where interventions are impractical is transport, particularly air transport for which there are minimal alternatives (Foran et al., 2005; Larsen et al., In press). The prospect of a wholesale switch from flights to video conferencing is highly improbable and, according to Foran et al. (2005; pp. 152), would likely herald the beginning of “the sustainability revolution”. Similarly, it will prove difficult to substitute specialised machinery that departments such as Engineering are dependent upon for teaching and research (Baboulet and Lenzen, 2010; Larsen et al., In press).

The range of potential interventions are also narrowed by SP favouring a small supplier-base. This makes it easier to enforce environmental criteria (Hakke and Seurling, 2009; Oruezabala and Rico, 2012), but can marginalise smaller corporations that commonly deploy the most innovative approaches regarding sustainable supply (Walker and Preuss, 2008). This marginalisation can be
particularly apparent in HE institutions since many of the goods they require such as stationary and ICT equipment tend to be supplied by large, often multinational corporations (Walker and Preuss, 2008).

2.3.2.2) Drivers for Change

External factors constitute the key drivers for SP processes (Seurling and Muller, 2008; Walker et al., 2008; Hoejmose and Adrien-Kirby, In press). Two main factors exist, one being governmental regulatory and legislative requirements (Seurling and Muller, 2008; Ageron et al., In press). Such regulation can familiarise organisations with SP concepts, and is particularly effective when organisations are proactive in their response (Walker et al., 2008; Brammer and Walker, 2011).

Customer demands represent the second factor (Seurling and Muller, 2008; Walker et al., 2008; Hoejmose and Adrien-Kirby, In press), to whom organisations aim to maintain or improve their image (Ageron et al., In press). The adoption of SP practices entails a pathway suitable for achieving such aims (Testa and Iraldo, 2010).

Although external factors act as the stimulus, SP only becomes truly operational when supplemented with internal resources, skills and support (Walker et al., 2008; Hoejmose and Adrien-Kirby, In press). Top management occupies a key role here (Brammer and Walker, 2011; Ageron et al., In press; Hoejmose and Adrien-Kirby, In press). They control the resources that are required to devise SP plans and to subsequently attain their respective goals (Brammer and Walker, 2011; Hoejmose and Adrien-Kirby, In press). Further, they can also drive shared values across organisations (Oruezabala and Rico, 2012).
3) Methodology

This section is structured as follows: Section 3.1 details how the consumption-based CF for the university and its individual departments were derived, whilst Section 3.2 describes how the utility of the CF results for informing SP decisions was assessed.

3.1) Estimating the Carbon Footprint

3.1.1) Scope 1 and Scope 2 Emissions

Scope 1 and Scope 2 emissions data for the year 2010/11 was measured previously by the university (see Appendix A). Measurements were made directly and applied the emission factors advised by Defra/DECC (2011), apart from for steam and low pressure hot water where a conversion factor of 0.21kgCO2e/ kWh was used (White, 2012).

3.1.2) Scope 3 Emissions

3.1.2.1) Input-output Modelling

A two-region input-output model created by the Centre for Sustainability Accounting was used as the basis to derive the Scope 3 CF (see supplementary material in Wiedmann and Barrett, 2011). IOA was applied since it encompasses the most efficient method for measuring the Scope 3 emissions of organisations as mentioned earlier (Wiedmann, 2009; Wiedmann et al., 2009).

The model utilises linear algebra to trace transactions throughout the supply-chain up to the final demand of goods or services by consumers (Hendrickson et al., 2006). The associated calculations have been addressed in work by Lenzen (2001b), Hendrickson et al. (2006) and Miller and Blair (2009), and will not be detailed here. A qualitative description of the basic steps within IOA is displayed in Figure 3 however.

3.1.2.2) Modelling Process

Expenditure data for the year 2010/11 was compiled by Central Purchasing in order to drive the input-output model as in step 2 (Figure 3). Data was classified according to the material group; the type of good or service being purchased (e.g. books, advertising and glassware), and the purchase group; which department was accountable for the purchase (e.g. Engineering, the Faculty of Arts and Estates Services). When in a foreign currency, expenditure data was converted into sterling using exchange rates published by HMRC (2012).
Being driven by expenditure data, the Scope 3 CF was determined by what the university spent money on. To elaborate, the university is spending money on business travel so its emissions are included in the CF, whereas commuting represents a private activity not paid for by the university and so is excluded from the CF. The focus is firmly on upstream emissions, with no consideration of the downstream emissions induced by university services. Such downstream emissions are likely negligible compared with the upstream emissions however (Lenzen, 2001a). The scope of analysis is made clear in Table 3.1.

A key part of the modelling process was matching each of the material groups to one of the 123 economic sectors in the input-output model. This entailed a laborious process when matching could not be made directly, and on several occasions a single material group had to be divided across several sectors. For instance, groceries had to be matched to: meat, fish, fruit and vegetables, dairy products, and other foods products. This issue was enhanced when the goods contained within material groups varied between purchase groups.

Upon completing the matching process, steps 3 and 4 (Figure 3) could be completed. By driving the model with expenditure data for single purchase groups the CF for its respective department was derived.
It was expected that summing expenditure data across all purchase groups would equate to total university expenditure, and so would be appropriate for deriving the CF of the university as a whole. However, the total obtained upon summing the expenditure across purchase groups was 19.92% less than the actual university procurement total. As such, an “unknown spend” category was created which added a further 19.92% expenditure to the value of each material group having been summed across product groups. Increasing material group expenditure in this way meant that the total university procurement expenditure was satisfied.

Results were aggregated into nine broad product categories (see Appendix B for their composition) for ease of comprehension. Resolution was increased to commodity-group level when a more detailed analysis was required.

Results were also normalised by expenditure. Such intensity metrics decouple emissions from the size of a department or product category, thus enabling more efficient decision-making (Wiedmann et al., 2009). Intensities are presented concurrently with absolute impacts so results retain their environmental relevance (de Vries and te Riele, 2006).

Full consumer responsibility is employed in order to avoid double-counting. Although the UoL and its suppliers have a role in causing its CF, an understanding of the total emissions embodied in the goods and services demanded by the university will be useful no matter how much of its upstream emissions it wishes to take responsibility for (Matthews et al., 2008).
3.1.2.3) Limitations

Together with the aforementioned limitations inherent within IOA (Lenzen, 2001a; Suh et al., 2004; Minx et al., 2008; Williams et al., 2009), a number of constraints enact upon the approach adopted here to estimate the CF of the UoL and its departments.

The Scope 3 CF is constrained by the university accounting system in two ways. The first and most prominent is the need to implement an “unknown spend category”, which, as a hypothetical average, is of no practical use to decision-makers. The second extends beyond just the accounting system, requiring the collection of additional data so that the scope of the analysis is more comprehensive.

Further, being constructed from data for one year, the CF is static. In reality however, the CF will be dynamic as university expenditure fluctuates from year-to-year (Wiedmann et al., 2009). Thus, it is difficult to establish whether results reflect “the norm” for the university’s CF.

3.3) Assessing the Utility of Carbon Footprint Results for Informing Sustainable Procurement

3.3.1) Semi-Structured Interviews

Five semi-structured interviews were conducted with a total six members of university staff that had a role in procurement (Table 3.2). The interviews followed a brief presentation of the CF results at the university-level and the department-level. Department-level results were differentiated according to the department the respondent worked in, ensuring that they were interested in the results and knowledgeable when it came to evaluating their utility (Burns, 2000).

Interviews were intended to investigate respondents’ perceptions of the utility of CF results for informing their procurement role in a heuristic sense (Oppenheim, 1992). Interviews were loosely guided by an agenda of pre-determined questions (see Appendix C) but proceeded mainly in a natural direction, thus allowing respondents to direct the interview with great richness and spontaneity (Oppenheim, 1992; Bryman, 2004). Such spontaneity was desirable for eliciting detailed perceptions from a respondent’s complex stock of knowledge (Holstein and Gubrium, 1995; Flick, 2009).

<table>
<thead>
<tr>
<th>Interview Number</th>
<th>Respondent(s)</th>
<th>Nature of Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>Central purchasing</td>
</tr>
<tr>
<td>2</td>
<td>B</td>
<td>Environmental</td>
</tr>
<tr>
<td>3</td>
<td>C</td>
<td>Social Science-based</td>
</tr>
<tr>
<td>4</td>
<td>D and E</td>
<td>Administrative</td>
</tr>
<tr>
<td>5</td>
<td>F</td>
<td>Innovation Centre</td>
</tr>
</tbody>
</table>

Table 3.2. Details of interview respondents

Interviews were intended to investigate respondents’ perceptions of the utility of CF results for informing their procurement role in a heuristic sense (Oppenheim, 1992). Interviews were loosely guided by an agenda of pre-determined questions (see Appendix C) but proceeded mainly in a natural direction, thus allowing respondents to direct the interview with great richness and spontaneity (Oppenheim, 1992; Bryman, 2004). Such spontaneity was desirable for eliciting detailed perceptions from a respondent’s complex stock of knowledge (Holstein and Gubrium, 1995; Flick, 2009).
The flexibility in the agenda meant that any outstanding issues could be revisited, whilst probes were also used to follow up interesting points (Miles and Huberman, 1994; Dunn, 2010). All interviews were recorded so attention could be devoted towards the respondents (Bryman, 2004), and so they could be analysed in detail afterwards (Oppenheim, 1992).

### 3.3.2 Sampling Strategy

Procurement staff were targeted as respondents since they were best-equipped for providing detailed and valid information about procurement issues within the university (Holstein and Gubrium, 1995). As such, they were the prime candidates for helping to address the third research aim (Patton, 1990). Six respondents was deemed a sufficient sample amidst time constraints. Given the inevitable homogeneity that exists between respondents under purposive sampling, high-level, overarching themes appropriate for analysis are usually uncovered after a small amount of interviews (Guest et al., 2006; Francis et al., 2010).

### 3.3.3 Analysis

Interview data was transcribed and coded to permit for detailed comparisons and insights (Burns, 2000). The coding process followed the guidance provided by Tesch (1990); initially identifying the major recurring themes before focusing upon subcodes that explained the data at a more specific level. The analytical process progressed from exploratory to inferential when data was appraised with reference to the SP literature (Miles and Huberman, 1994; Flick, 2009). The final coding structure is displayed in Appendix D.

### 3.3.4 Limitations

Despite the sample size being sufficient for identifying high-level themes, interview data is likely far from saturated and additional insights could have been gained had more interviews been feasible (Guest et al., 2006). It would also have been beneficial had these additional interviews been made with staff from departments with a higher CF, since respondents were biased towards departments with relatively low CFs as a result of time constraints.

Although respondents were knowledgeable of procurement issues, this was not the case for the majority considering carbon footprinting. This meant that the concept has to be explained during the presentation which may have induced an interviewer effect with respondents unwilling to criticise something they don't fully understand (Burns, 2000). Of course this may also have had the opposite effect as respondents were free of any preconceptions regarding CFs, potentially increasing the validity of results.
4) Results

Results are presented in two sections. Section 4.1 details CF results, this at the university-level in Section 4.1.1 and the department-level in Section 4.1.2. Section 4.2 presents interview results.

4.1) Carbon Footprint Results

4.1.1) University-Level

4.1.1.1) The Total Carbon Footprint and its Composition

The total CF of the UoL for the year 2010/2011 was 161,819t CO2e. Figure 4.1 shows that just over half of the CF was made up of Scope 3 emissions (51%), whilst Scope 2 emissions also made a significant contribution (31%).

Accordingly, the UoL accrues the majority of its emissions indirectly through procurement, although it also induces a considerable amount through electricity consumption. The latter is recognised in the university’s Carbon Management Plan (University of Leeds, 2011), and is attributed to having 44% of academic space contained within listed building which limits potential interventions such as double glazing and over cladding.

Figure 4.1. Breakdown of the University of Leeds’ Carbon Footprint according to the GHG Protocol Scopes and Scope 3 broad product categories
4.1.1.2) Analysis by Broad Product Category

The contribution that each of the Scope 3 broad product categories made towards the CF is conveyed in Figure 4.1. Utilities and construction comprised the main emissions source (13%), with considerable impacts also from machinery and computers (9%), and manufactured products (8%). Raw materials and chemicals (6%), transport and communication (5%), and public services (5%) all encompassed modest emissions sources, whilst the remaining categories had only minor impacts.

A different perspective of the product categories is obtained when normalising the results by expenditure as in Figure 4.2. Despite being the most emitting product category in absolute terms, utilities and construction has the third lowest emissions intensity. A similar picture is evident for machinery and computers. With reference to Figure 4.3, the volume of expenditure within these categories likely induced most of the emissions rather than the commodities themselves being inherently polluting.

Raw materials and chemicals and transport and communication convey the opposite pattern, having relatively low emissions in absolute terms, but two of the highest emissions intensities (Figure 4.2). It is likely that some of the commodities purchased within these categories are inherently polluting, with expenditure volume playing a lesser role (Figure 4.3).

Manufactured products is the only category where emissions are relatively high in absolute and intensity terms (Figure 4.2), thus the volume and type of purchases are likely having an impact in this category (Figure 4.3). Public services and business services are the contrary to manufactured products (Figure 4.2), and emissions are firmly driven by expenditure (Figure 4.3).

4.1.1.3) Analysis by Detailed Commodity Groups

In order to interrogate the origins of the above patterns, the level of analysis was increased to the commodity group-level. Due to space limitations, results are presented for only five overarching product categories. These product categories entailed mainly the largest emissions sources and contained findings especially pertinent for decision-making. See Appendix E for the absolute emissions of all commodities.

Miscellaneous manufactured products comprised by far the most prominent source of emissions within the manufactured products category (Figure 4.4), contributing 7% of the total CF (Figure 4.5). Such an impact accrued through supplementing a relatively high emissions intensity with a large expenditure volume (Figures 4.4 and 4.5).

Most of the commodity groups within machinery and computers are characterised by relatively low emission intensities (Figures 4.6), although the impact of special purpose machinery was augmented by its relatively high emission intensity (Figure 4.6). Accordingly, special purpose machinery is the
A Worthy Investment? Evaluating the Utility of Carbon Footprints for Informing Environmental Policy Within Organisations

greatest source of emissions, making up 4% of university emissions, whilst office machinery and computers contributes most of the remaining emissions from the category (3% of university emissions) (Figure 4.7).

![Figure 4.2](image1.png)

*Figure 4.2. Emissions from Scope 3 broad product categories in both absolute and intensity terms*

![Figure 4.3](image2.png)

*Figure 4.3. Impacts of Scope 3 broad product categories in terms of both emissions and expenditure*
Figure 4.4. Emissions from Manufactured Products’ commodity groups in both absolute and intensity terms

Figure 4.5. Impacts of Manufactured Products’ commodity groups in terms of both emissions and expenditure
A Worthy Investment? Evaluating the Utility of Carbon Footprints for Informing Environmental Policy Within Organisations

Figure 4.6. Emissions from Machinery and Computers’ commodity groups in both absolute and intensity terms

Figure 4.7. Impacts of Machinery and Computers’ commodity groups in terms of both emissions and expenditure
Construction dominates the utilities and construction CF (Figure 4.8); this to the extent that it constitutes 11% of the total CF (Figure 4.9). Figure 4.9 suggests this is largely due to the volume of expenditure devoted towards it. Despite being one of the most emissions-intensive commodity groups (Figure 4.8), electricity life cycle emissions received insufficient expenditure to make a notable impact on the total CF, contributing just 1% of emissions (Figure 4.9).

Figure 4.8. Emission from Utilities and Construction’ commodity groups in both absolute and intensity

Figure 4.9. Impacts of Utilities and Constructions’ commodity groups in terms of both emissions and expenditure
Air transport induces the most emissions within transport and communication (3% of university emissions) (Figures 4.10 and 4.11). This impact is fostered through its sizeable emissions intensity, which meant a notable amount of emissions were evoked despite a relatively small expenditure volume (Figure 4.11).

Figure 4.10. Emissions from Transport and Communications’ commodity groups in both absolute and intensity terms

Figure 4.11. Impacts of Transport and Communications’ commodity groups in terms of both emissions and expenditure
Figure 4.12 shows that education is the predominant source of emissions within public services, its impact sufficient to contribute 4% of the total CF (Figure 4.13). This is likely due to the volume of expenditure devoted to the group since it is associated with a low emissions intensity (Figures 4.12 and 4.13).

Figure 4.12. Emissions from Public Services’ commodity groups in both absolute and intensity terms

Figure 4.13. Impacts of Public Services’ commodity groups in terms of both emissions and expenditure
4.1.2) Department-Level

Figure 4.14 displays the CFs of individual departments and the contributions they make towards university Scope 3 emissions. It also shows their composition according to broad product categories.

All departmental analysis is focused solely on Scope 3 emissions since Scope 1 and Scope 2 emissions data was unavailable at the department-level.

4.1.2.1) Analysis by Departmental Carbon Footprint and Broad Product Category

The departmental CFs are extremely variable, both in terms of their total and their composition. Estates Services is clearly the most emitting department, inducing 28% of Scope 3 emissions. The vast majority of these emissions originate from utilities and construction (72%), with manufactured products also a significant source (19%).

Unknown spend was the next biggest contributor, though representing a hypothetical average it will not be analysed. As such, after Estates Services the Faculty of Medicine and Health represents the second most emitting department, sourcing 16% of Scope 3 emissions. Its CF is spread across a number of product categories as might be expected from such a diverse department: with raw materials and chemicals (25%), manufactured products (16%), machinery and computers (18%), transport and communication (11%), and public services (21%) all providing notable contributions.

As at the university-level, normalising the results by expenditure provides a different perspective on results (Figure 4.15). Despite being the most emitting departments in absolute terms, Estate Services and the Faculty of Medicine are amongst the middle-ground for emissions intensities. Thus whilst the nature of their purchases may have contributed towards their large emissions, expenditure volume may have also had a profound impact. This is supported by Figure 4.16.

The CFs for the Faculty of Engineering and the Faculty of Biological Sciences are similar in terms of their absolute emissions, both contributing 7% of Scope 3 emissions (Figure 4.14). Biological Sciences however possesses an emissions intensity much larger than Engineering (Figure 4.15).

This can be attributed to the variable procurement patterns between the departments. The largest contrast exists between machinery and computers, which sources 22% of emissions for Biological Sciences and 50% for Engineering, and raw materials and chemicals, which sources 43% and 11% of emissions respectively. This pattern is to be expected since it is in accordance with the nature of the research conducted within the departments, and culminates in Biological Sciences having a greater emissions intensity than Engineering, chemicals generally being more emissions-intensive than machinery (Figure 4.2).
Figure 4.14. Departmental carbon footprints
A Worthy Investment? Evaluating the Utility of Carbon Footprints for Informing Environmental Policy Within Organisations

Figure 4.15. Departmental emissions in both absolute and intensity terms

Figure 4.16. Impacts of departments in terms of both emissions and expenditure. Note* emissions relate to just Scope 3
The remaining 10 departments beyond Engineering and Biological Sciences make only minor contributions to university Scope 3 emissions individually (Figure 4.14). However, combined they account for 24% of Scope 3 emissions and mitigation opportunities do exist in these departments. For instance, emissions hotspots are evident for: food and drink (82% of emissions) in Catering Services; paper and publishing (67% of emissions) within Media; raw materials and chemicals (36% of emissions) for the Faculty of MAPS; and food and drink (37% of emissions) and public services (32% of emissions) in Halls of Residence, all of which are categories associated with the service provided or research conducted by the department.

4.2) Interview Results

Interview results are split into two sections. Section 4.2.1 details the functionality of CF results for informing SP decisions, whilst Section 4.2.2 covers the practicality of implementing changes within procurement procedures.

4.2.1) The Functionality of Carbon Footprint Results

The functions CF results can uptake for informing SP decisions were divided into two resounding purposes; the provision of evidence to support current actions, and the provision of novel information that was previously unknown.

Regarding the provision of evidence, a common recognition amongst respondents related to the benefits arising from the quantitative nature of the results, benefits which appear multifaceted:

“…I think sometimes people need something shoving under their nose, I think they need statistics to prove something so they think more about the little things they do in their everyday life” (Respondent B, 2012)

“…to actually have some cold, hard data that we can show to people and say look, this is the reason we want to be greener in this area because we can save money and save emissions, it will make a proper difference” (Respondent D, 2012)

Respondent B references the awareness-raising potential of the results which was deemed useful not only within purchasing domains, but also within general policy spheres such as the Green Impact Initiative (Respondent B; C, 2012).

Respondent D refers to using the results to justify actions through the presence of win-win situations where emissions and costs can be reduced simultaneously. Such no-brainer decisions were recognised as pivotal for engaging management and leveraging SP procedures (Respondent A; D; E; F, 2012). Accordingly, the uncovering of previously unknown win-wins harnessed valuable information:

“…what the results do is they identify areas where there are quick wins, areas that we could skew in our favour…this could be useful for targeting some of our new projects because it gives us information that we don’t currently have” (Respondent A, 2012)
Information was perceived as enlightening at both the broad product group- and detailed commodity group-levels. Analysis at the product group-level gave an initial indication of the impacts of different purchase areas, with respondents C, D and E (2012) all surprised by the minor impact of paper:

“Our paper wasn’t a problem area was it… it still wouldn’t compare to the public and business services, so it’s good for directing us because it would be quite easy to get stuck on paper for the next decade” (Respondent E, 2012)

Commodity-groups could then be analysed to guide more concrete actions within purchasing strategies:

“…I look after laboratory supplies, chemicals and things like that, so it’d be useful to identify the impacts at these specific levels and then target to reduce expenditure in the areas with the largest impact” (Respondent A, 2012).

Respondent F, who was most knowledgeable in terms of CF and SP issues, was more apprehensive regarding the utility of CF results. Her criticism was largely directed at the sophistication of the input-output model, which she deemed incapable of presenting a true reflection of Scope 3 emissions: “the tool doesn’t recognise the detail, the processes in manufacturing and the waste generated” (Respondent F, 2012).

Further, despite arising as a result of the university accounting system rather than the model itself, Respondent F (2012) was particularly critical of the “unknown spend” category: “It will still give you a figure but that’s uncategorised so what does that even mean, what does it mean, it means nothing!”

Constraints also arose from the aggregation issues within IOA, with particular reference being made to the opacity of the miscellaneous manufactured products and other business services commodity-groups (Respondent D; E, 2012). Such opaque categories were regarded as having little use in directing purchasing decisions since they failed to define an explicit commodity to focus on (Respondent C, 2012).

Overall the inability to resolve the finer details of Scope 3 emissions doesn’t detract from the utility of CF results since, as mentioned, even an elementary mapping of emissions hotspots was perceived as useful by most respondents. However, the latter two constraints are more significant. As pointed out by Respondent F (2012), emissions mean little if their source cannot be identified without a certain amount of precision.

4.2.2) The Practicality of Implementing Changes within Procurement

Although CF results were generally perceived as efficient in revealing areas where purchasing strategies could be adapted, particularly in the pursuit of win-wins, a number of practicality issues were identified for when implementing such changes.
University policies and the purchasing system were depicted as a constraint upon any major changes in procurement strategies (Respondent B; C; D, 2012). The impact of these factors is exemplified by Respondent C (2012): “I feel a bit powerless through the university system because we’re only supposed to use certain suppliers”.

Travel in particular was cited as an area where procurement staff have little influence:

“…there are specific rules in the university about transport, you can’t turn round to staff and say you can’t use it or it’s against university procedures to use domestic flights and stuff…it’s a really grey area to be honest” (Respondent B, 2012).

This illustrates that some areas of procurement are adverse to change regardless of whether they are identified as emissions hotspots.

A limited resource-base also appears to restrict the application of SP policies. All respondents expressed that ultimately procurement decisions are based upon costs, and, amidst budget cuts, the cheapest option often prevails over the environmental option:

“…it’s been quite a difficult year because there’s not as much money to buy anything, a lot of the time people will just see who will do something the cheapest without even bothering to look at the environmental side of it” (Respondent D, 2012)

Respondents A (2012) and F (2012) attribute this disregard for the environment to the lack of a clear message regarding sustainability from higher governing levels within the HE sector and beyond. Clarifying what is required in terms of sustainability and mandating SP were perceived as necessary steps to rectify this situation:

“When our government knows more about sustainability, particularly procurement, and they set specific targets that are mandatory, that’s when it’ll [the environment] come to the top of the pile” (Respondent F, 2012)

Respondent F (2012) also alluded to the potential of pressure coming from the bottom-up, most notably from students who are: “very switched onto the environment...so universities will have to listen to them because they want students to come to their institution and purchase their education”. As such, combining pressure from the top-down and the bottom-up could entail a mutualistic relationship capable of propelling the environment up the ladder of priorities.

A further barrier to SP commonly identified by respondents was culture, specifically the lack of an environmental conscious amongst individuals (Respondent A; B; C; D; E, 2012). This undoubtedly factors into the prioritisation of costs as discussed, but resonates more with individual values whereas resource limitations have a more general, university-wide impact:

“Apathy is a big problem. Obviously I’ve got an interest in it [the environment] because I’m on the Green Team but some people would rather just live their lives and not think about it” (Respondent C, 2012)
Education and training were identified as potential methods to mobilise environmental-thinking:

“…looking at culture something we’re targeting is how to get people into training, it might be part of a training package that doesn’t just include sustainable procurement but also includes other areas of interest so you get more staff in” (Respondent A, 2012)

Respondent F (2012) reinforced the potential of training, but also expressed concerns that time and workload constraints could limit attendance. Similarly, Respondent C (2012) held reservations about the success of training: “I think there are a few people who will automatically be a bit resistant to having values pushed on them”.
5) Discussion

Two overarching sections are present here: Section 5.1 entails a benchmarking analysis of the UoL’s CF, whilst Section 5.2 evaluates the utility of CF results for informing SP.

5.1) Benchmarking the University of Leeds’ Carbon Footprint

The efficient benchmarking of organisational CFs is a currently an arduous process given inconsistent organisational boundaries and the subjective aggregation of goods and services into higher-level categories (Ozawa-Meida et al., In press). These issues inevitably constrain the benchmarking analysis employed here, thus results should not be interpreted as providing a valid comparison of environmental performance. However, such analysis can help clarify boundary issues where the scope of an organisation’s CF is not as comprehensive as others, and thus can help facilitate the defragmentation of CF research within the HE sector.

The benchmarking analysis focuses initially on the CF value and its overarching composition in Section 5.1.1 before scrutinising the Scope 3 components specifically in Section 5.1.2. Benchmarking is carried out against the studies contained within Table 2.1, albeit with the exception of Klein-Banai et al. (2010) and Letete et al.’s (2011) research for reasons previously explained.

5.1.1) Overarching Composition

Emissions were normalised by the number of students at each HE Institution to decouple their emissions from their size (Wiedmann et al., 2009). Number of students was chosen since it offers a more consistent metric than expenditure which suffered from boundary issues across institutions. Results are displayed in Figure 5 with the exception of YU which returned the anomalous value of 77.689 tCO2e/student. This is attributable to the extensive nature of the estate compared with the other HE institutions.

As stated, results are not indicative of environment performance but can be used to investigate why CFs differ. For instance, the low emissions intensity at DMU (Figure 5) could arise due to the nature of the institution which has a strong focus on Social Sciences, and lacks dedicated Engineering and Medical departments.

The composition of the UoL’s CF strikes greatest accordance with that for LU. Despite accruing the majority of their emissions from Scope 3 sources, 51% for the UoL and 56% for LU, this occurs at a lesser extent than for other studies. This arises for the same reason at both institutions, outdated and inefficient energy infrastructure (Lancaster University and ARUP, 2007; University of Leeds, 2011).
Potential interventions are restricted at the UoL because of the large proportion of listed buildings within the institution (University of Leeds, 2011). The rigidity of the situation means that behavioural campaigns present the only viable route to reduce direct energy consumption further. However, given that the impact of downstream emissions is often minor (Lenzen, 2001a), focusing on Scope 3 emissions encompasses the prime option for emissions abatement.

5.1.2) Scope 3 Components

Construction being one of the predominant Scope 3 components at the UoL is concurrent with results for other HE institutions (Thurston and Eckelman, 2011; Larsen et al., In press; Ozawa-Meida et al., In press). However, its impact is around half of that estimated elsewhere, making up 11% of emissions compared to around 20%.

This dampened impact at the UoL could be a victim of the static CF. Ozawa-Meida et al. (In press) constructed a time series of procurement emissions for DMU and found construction impacts particularly dynamic as a result of fluctuations in building investment. This could also be the case at the UoL. Despite significant new builds such as the Energy Research Building coinciding with the study period, construction occurred at a lesser extent than in previous years owing to cuts in the Capital Development budget (Winter, 2012). As such, results reflect construction emissions during a dip in investment, and they were likely higher in previous years.
Electricity life cycle emissions were not quite negligible as at NTNU (Larsen et al., In press) but made only a minor contribution to the CF. However, this may be an underestimate as results from DMU demonstrate that extending the organisational boundary to include emissions sources such as energy use in private halls of residence can make the impact of electricity life cycle emissions much more noteworthy (Ozawa-Meida et al., In press). Including energy use at private halls of residence would increase the CF from the UoL since this would encompass energy use at three different residences for almost 1200 students (University of Leeds, 2012a).

Comprising 5% of the CF, transport emissions were much less significant at the UoL compared to other HE institutions, them being over 20% greater at both DMU (Ozawa-Meida et al., In press) and LU (Lancaster University, 2012a). At YU emissions were only 3% greater (Thurston and Eckelman, 2011), but a lack of transparency as to what transport activities were considered makes comparison futile.

Much more worthwhile comparisons can be made with results from DMU and LU, which are explicit with regards to what activities made up the transport emissions. Such transparency makes it obvious that transport emissions at the UoL were underestimated. Commuting which comprised 18% and 16% of the total CFs at LU (Lancaster University, 2012a) and DMU respectively (Ozawa-Meida et al., In press), was excluded from the UoL CF.

Business travel which encompassed the primary transport activity in the UoL CF made up only 2% of emissions at DMU (Ozawa-Meida et al., In press). However at LU business travel is more significant, making up 13% of the CF (Lancaster University, 2012). Though percentages are relative to the total CF, questions arise as to how an institution that employs a third of the staff of the UoL (Lancaster University, 2012b; University of Leeds, 2012b) can accrue business travel emissions over twice as significant.

Inspecting the absolute values shows that business travel accrued 9360 tCO2e at LU (Lancaster University, 2012a), and 7326 tCO2e at the UoL. Whilst the exact characteristics of business travel at LU are unknown, it is unlikely that it would accumulate more emissions than at the UoL. The reason for this smaller value at the UoL and also its minor contribution to the DMU CF can be tentatively attributed to the deployment of IOA to derive business travel emissions. As such, results are likely coarse and underestimated (Lenzen, 2001a; Suh and Nakamura, 2007; Williams et al., 2009), lacking the level of detail obtained through PA which was utilised at LU (Longton, 2012).

Comprising 9% of the CF, emissions from machinery and computers were greater than at DMU, where they made up 3% of the CF (Ozawa-Meida et al., In press), and less than NTNU, where they made up 19% of the CF (Larsen et al., In press).

It should be noted that at DMU machinery is aggregated with manufactured products which comprised 3% of the CF (Ozawa-Meida et al., In press), and thus emissions from machinery and
computers may be slightly higher. Such subjective aggregation issues are especially prevalent considering manufactured products across studies. For instance, at NTNU manufactured products are aggregated with food and books (Larsen et al., In press), and for UK Schools manufactured products are aggregated with machinery, chemicals and paper (GAP et al., 2006). This irredeemably complicates the comparison of emissions accumulating from manufactured products across studies; therefore the category will not be appraised.

Despite a slight discrepancy at DMU, machinery and computers are aggregated more consistently and are appropriate for comparison. Experimental research and Engineering in particular require considerable amounts of machinery, areas where NTNU specialises. As such, machinery and computers comprise a significant proportion of the CF (Larsen et al., In press). Within DMU however the largest departments are social science-oriented, and thus machinery and computers have just a minor impact (Ozawa-Meida et al., In press). The UoL constitutes a middle ground, having large, dedicated departments for Engineering and Medicine where machinery and computers induce a considerable amount of emissions, though this impact is partly diminished by emissions accumulating from a diverse range of sources in other departments. Accordingly, the amount of emissions accruing from machinery and computers depends on the character of research and teaching carried out within the institution.

In contrast to other HE institutions, public services (5%) induce more emissions than business services (2%) at the UoL, figures comparable to those from Trodheim (Larsen and Hertwich, 2009). The activities inducing public services emissions however differ according to purposed service provision, with public services emissions accruing mainly from educational services such as the recruitment of temporary staff and training courses at the UoL, whilst sewage and refuse disposal was the prominent emissions source at Trodheim (Larsen and Hertwich, 2009).

Consistent with other studies (GAP et al., 2006), particularly in the HE sector (Thurston and Eckelman, 2011; Larsen et al., In press; Ozawa-Meida et al., In press), food and drink and paper and publishing make only minimal contributions to the UoL CF.

Chemicals and raw materials are more significant at the UoL than for other HE institutions however, comprising 6% of the CF compared to 2% at NTNU (Larsen et al., In press), and just 1% at DMU (Ozawa-Meida et al., In press). Again, this can be tentatively explained by the institutional character. Large Biological Sciences and Medical departments at the UoL require vast amounts of chemicals for experimental research. Conversely, such research is much less prominent at DMU, thus fewer emissions accrue from raw materials and chemicals since they are not required at the same extent as at the UoL (Baboulet and Lenzen, 2010).
5.2) Evaluating the Utility of Carbon Footprints for Informing Sustainable Procurement

CFs fulfil a vital requirement within SP by providing quantitative information which allows GHG impacts across complex supply chains to be better understood (Sundarakani et al., 2010; Young, 2010). Utilising this evidence CFs have two potential applications; the first is as an elementary screening tool for identifying emissions hotspots, as discussed in Section 5.2.1; the second is as a detailed analytical tool to explore potential procurement strategies, as discussed in Section 5.2.2. Both applications are constrained by practicality issues, but can also be driven by a number of factors as documented in Section 5.2.3.

5.2.1) Carbon Footprints as a Screening Tool

Supporting the literature and previous studies (Larsen and Hertwich, 2009; Minx et al., 2009b; Wiedmann et al., 2009; Berners-Lee et al., 2011; Ozawa-Meida et al., In press), the basic function of CF results was a screening assessment to identify emissions hotspots accruing through procurement processes. Both the location and the nature of hotspots are identifiable which is beneficial for guiding mitigation efforts (Wiedmann et al., 2009).

Such screening assessments are useful for supporting current actions within SP, but their utility extends beyond solely evidential purposes. Additional benefits were associated with its awareness-raising potential, this providing capacity to elevate environmental issues in the conscious of individuals (Weidema et al., 2008). This awareness-raising potential was also realised in other studies (Ozawa-Meida et al., In press; Larsen and Hertwich, 2010b) and constitutes a potential vehicle with which to erode cultural resistance, which was reaffirmed here as a key barrier to SP procedures (Young et al., 2010; Ageron et al., In press; Hoejmose and Adrien-Kirby, In press).

Surpassing cultural resistance can take a significant amount of time since it inevitably involves prompting changes against well-established organisational practices (Haake and Seurling, 2009). However, awareness-raising neither adds to workload nor adjust processes so as to disempower individuals, thus its prospects for reducing cultural resistance rather than aggravating it appear promising (Foran et al., 2005; Baboulet and Lenzen, 2010).

Awareness-raising could also complement the training and education of staff, a more direct method of ensuring individuals are well-informed regarding environmental issues and SP processes. Arguably training provides the better option for providing more deliberative support to staff, who could also collaborate with academic staff and build their capacity for applying IOA (Baoulet and Lenzen, 2010; Burritt and Tingey-Holyoak, In press). However, for individuals who are averse to having values imprinted on them, awareness-raising can slowly alleviate their resistance through the provision of hard-hitting quantitative evidence that supports the environmental agenda.
A Worthy Investment? Evaluating the Utility of Carbon Footprints for Informing Environmental Policy Within Organisations

Other than awareness-raising, the uncovering of win-win situations where emissions can be reduced whilst potentially making financial savings was as a key gain from the CF results. Concurrent with previous research (Berners-Lee et al., 2011), cost-efficient mitigation routes were preferred by practitioners, and resonate especially with senior management.

However, reported benefits from SP are often intangible (Seurling and Muller, 2008; Testa and Iraldo; Ageron et al., In press), and thus assuming a mutualistic relationship between environmental and economic performance is naive. However, there are cases where improving environmental performance through SP practices has resulted in financial savings (Rao and Holt, 2005). It remains to be seen how results will transpire into practice in the long-run but more positive cases could propagate from the guidance provided by CFs, with organisations previously lacking a tool to evaluate the potential financial gains from SP (Ageron et al., In press).

Should CF results succeed in evoking tangible benefits from SP practices, concerns may arise in the targeting of mitigation efforts. By focusing on the obvious opportunities where emissions and costs can be reduced simultaneously, attention may be diverted from important emissions sources with a high intensity such as air transport and manufactured products. As such, the importance of emissions-intensive sources should be stressed within awareness-raising schemes and training.

5.2.2) Carbon Footprints as a Detailed Analytical Tool

Despite suggestions otherwise (Larsen and Hertwich, 2009; Baboulet and Lenzen, 2010), CFs are ill-equipped to act as a detailed analytical tool for investigating potential procurement strategies. This is especially true when IOA is deployed, its rudimentary results lacking the required precision to direct specific purchasing decisions. Such imprecision arises from the aggregation error (Lenzen, 2001; Suh and Huppes, 2005; Minx et al., 2008), and whilst this does not detract from the screening function of CFs, it constrains the exploration of alternative procurement strategies (Wiedmann et al., 2009). Ozawa-Meida et al. (In press) found this limitation particularly apparent when considering the substitution of goods and services, though it can also obscure which goods and services should be targeted in mitigation efforts in the first place.

This can be partly rectified by hybridising analysis and using detailed process data to identify and differentiate between goods and services within purchase areas (Berners-Lee et al., 2011). Also, by deriving more meticulous results, HCLA also provides a truer picture of Scope 3 emissions compared to IOA (Bullard et al., 1978; Suh et al., 2004; Minx et al., 2008). This increased detail comes at the expense of time and complexity however (Lenzen, 2001a). Thus, when deployed, HCLA should be guided by SPA and encompass optimal collaboration between academics and procurement staff (Lenzen, 2002; Wiedmann, 2009; Berners-Lee et al., 2011).
Issues external to IOA also prevent CFs from occupying a role more substantive than a screening assessment, with inconsistencies in accounting systems culminating in the presence of uncategorised emissions. This problem has resided largely unrecognised but is pressing since it is impossible to mitigate emissions that are accumulating from an unknown source.

5.2.3) Wider Practicality Issues

Undoubtedly the identification of emissions hotspots within supply chains harnesses genuine utility for SP. However, actions to address these hotspots can often be constrained by practicality issues.

Central policies within an organisation often limit the manoeuvrability of procurement strategies (Foran et al., 2005; Young et al., 2010), as was especially prevalent regarding air transport. The prospect of a large-scale reduction in flights is implausible even within the most environmentally-conscious organisations. This is since there are no viable alternatives despite prospects such as video-conferencing (Foran et al., 2005).

Procurement structures that mandate staff to use specified suppliers can also limit the efficacy of CF results. Although a reduced supplier-base entailing commitments to certain suppliers supposedly makes it easier to enforce environmental criteria (Hakke and Seurling, 2009; Oruezabala and Rico, 2012), it constrains flexibility in adapting procurements strategies in response to CF results. Further, it would be naïve to dismiss that such commitments are also based upon economic motives.

Findings reaffirmed that amidst budgetary constraints the cheaper, more economical option usually takes precedence over the environmental option in procurement (Min and Galle, 2001; Seurling and Muller, 2008; Michelson and de Boer, 2009; Brammer and Walker, 2011). Procurement staff lack the capacity to alter these dynamics, with budgetary control residing with higher management (Brammer and Walker, 2011; Hoejmose and Adrien-Kirby, In press). As such, the utility of CF results and the extent of SP practices could rest largely with management. Managers at proactive organisations like the UoL may be attracted to using CFs to identify environmental options that can be pursued without exerting additional pressure upon budgets (Ageron et al., In press), this akin to the win-win situations previously discussed.

However, the practicality of win-wins will have to be scrutinised so as not to diminish the quality of the service provided (Bala et al., 2008; Berners-Lee et al., 2011). For instance, reducing emissions from the education commodity-group could be cost-effective at the UoL, but would also be detrimental to the quality of teaching at the university. Further, departmental emissions hotspots often correspond with purchase areas vital to their research or service provision.

Where managers are less proactive at pursuing environmental options in procurement, an external stimulus may be necessary to induce SP procedures. Consistent with previous research, pressure from both the government and customers constituted the key drivers here (Seurling and Muller, 2008;
Walker et al., 2008; Ageron et al., In press). The potentially mutualistic relationship between the two drivers has received surprisingly little attention however.

The foundations for initiating such a relationship are arguably in place in the HE sector. By highly publicising the CF reports mandated by HEFCE (2010), HE institutions will be forced to assign greater priority to their environmental agendas in order to maintain their student-base. This pressure arises as a result of students increasingly consulting environmental credentials when considering where to study.

Such external pressure will become efficacious at driving SP practices when managers acknowledge its importance, and thus devote sufficient resources and support to it (Walker et al., 2008; Hoejmose and Adrien-Kirby, In press). This will enable the attainment of SP goals and the diffusion of environmental values across the organisation (Brammer and Walker, 2011; Oruezabala and Rico, 2012). Should the priority of SP increase in such a fashion, CFs could likely become a necessity to guide policy and broadcast its progress.
6) Conclusion

Theoretically, consumption-based CFs harness great potential for guiding environmental policy within organisations. SP in particular represents a policy domain that may benefit from such guidance.

Until now, how this potential transfers into practice has lacked thorough investigation. Previous research has failed to attune to the methodological implications that can culminate in inaccurate or incomparable CFs, whilst insufficient engagement with the practical realities of SP has left the policy relevance of carbon footprinting fallible. This paper used the UoL as a case study to address these issues.

The UoL CF for the year 2010/11 was 161,819t CO2e, the majority of emissions accumulating from Scope 3 sources (51%), though Scope 2 emissions were also considerable (31%). Benchmarking results against the CFs of other HE institutions however suggested that Scope 3 emissions were likely underestimated due to the exclusion of some potentially important emissions sources from the organisational boundary.

This was most apparent for transport emissions which comprised only 5% of emissions at the UoL, compared with values of around 20% for other HE institutions. This was attributed to the exclusion of commuting from the CF, and the utilisation of aggregated input-output data to derive business travel emissions rather than the more precise PA. These inconsistent organisational boundaries, along with the discrepancies that exist between emissions categories when commodity groups are subjectively aggregated to a higher level constrain any effective comparison of environmental performance across organisations. In order to rectify this, the definition of both standardised organisational boundaries and emissions categories is imperative.

Should flawless methodological foundations prevail in the future, due consideration should also be given to the characteristics of an organisation when analysing its environmental performance. HE institutions renowned for social science-based research will likely possess a smaller CF than an institution where experimental research and Engineering are predominant. This is since the latter institution will require more emissions-intensive goods such as specialised machinery and chemicals, which often transpire to induce a significant amount of absolute emissions. Further, should the CF be static results should not be taken at face value since CFs are sensitive to fluctuations in investment, as was observed with construction emissions.

CFs undoubtedly can supplement SP policies by providing a screening assessment to identify the location and nature of emissions hotspots accruing through complex supply chains. This can either support current actions or provide novel information to direct mitigation efforts.
The uncovering of potential win-win situations was of particular use since they are attractive to management and can leverage SP practice. Despite suggestions that win-wins rarely transpire from SP practice, a tool capable of evaluating financial savings was previously lacking, and future research is required to assess whether the direction provided by CFs can derive tangible benefits for organisations.

If CFs prove successful in resolving financial savings then an increase in their implementation is inevitable. Here, procurement decisions can be directed to reduce emissions whilst ensuring the quality of the service maintains intact. If savings are not quite as clear cut, external pressure from government regulation and environmentally-aware students may be required to heighten the environment on the ladder of priorities within HE institutions. Such pressure is also required to ensure that the institutional policy environment is flexible enough to accommodate the pursuit of environment options within procurement; otherwise little inroads will be made from CF results.

Error arising from the university accounting system combined with the aggregation issues within IOA meant that CF results were futile for guiding procurement decision in certain areas where the sources of emissions could not be explicitly identified. The aggregation issues can be partly rectified by substituting input-output data for more detailed process data. This will provide a truer reflection of Scope 3 emissions and also permit the exploration of alternative procurement strategies. As such, hybridising the analysis represents a logical avenue for further research.

These issues however did not constrain the screening application of the CF, neither its awareness-raising potential which has the capability to erode cultural resistance to the environmental agenda. Thus, in practice, CFs undoubtedly are useful for informing SP decisions.
7) References


A Worthy Investment? Evaluating the Utility of Carbon Footprints for Informing Environmental Policy Within Organisations


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8) **Appendix**

A. **Scope 1 and Scope 2 Emissions Data**

*Table 8.1. Scope 1 and Scope 2 data measured directly for the University of Leeds. Note* “other fuels” *contains biomass wood pellets and chilled water*

<table>
<thead>
<tr>
<th>Source</th>
<th>Energy Consumption (kWh unless noted)</th>
<th>Emissions (kg CO2e )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil</td>
<td>54,760</td>
<td>15,805</td>
</tr>
<tr>
<td>Gas</td>
<td>51,446,473</td>
<td>9,445,572</td>
</tr>
<tr>
<td>Electricity</td>
<td>83,741,761</td>
<td>43,921,695</td>
</tr>
<tr>
<td>Coal</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Steam/hot water</td>
<td>84,710,351</td>
<td>17,789,174</td>
</tr>
<tr>
<td>Other fuels*</td>
<td>5,039,562</td>
<td>964,004</td>
</tr>
<tr>
<td>Fuel use in vehicle fleet</td>
<td>35,770 litres</td>
<td>88,908</td>
</tr>
<tr>
<td>Total</td>
<td>224,992,907</td>
<td>72,136,250</td>
</tr>
<tr>
<td>Total (none-residential)</td>
<td>171,850,448</td>
<td>57,773,976</td>
</tr>
<tr>
<td>Total (residential)</td>
<td>53,142,459</td>
<td>14,362,275</td>
</tr>
</tbody>
</table>

B. **Composition of Scope 3 Broad Product Categories**

See overleaf.
### Tables 8.2 a, b and c. Composition of broad product categories

<table>
<thead>
<tr>
<th>Product Category</th>
<th>Commodity Group</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Raw Materials &amp; Chemicals</strong></td>
<td>2: Forestry products</td>
</tr>
<tr>
<td></td>
<td>7: Aggregates</td>
</tr>
<tr>
<td></td>
<td>37: Inorganic basic chemicals</td>
</tr>
<tr>
<td></td>
<td>38: Organic basic chemicals</td>
</tr>
<tr>
<td></td>
<td>39: Fertilisers etc.</td>
</tr>
<tr>
<td></td>
<td>42: Paints, varnishes etc.</td>
</tr>
<tr>
<td></td>
<td>43: Pharmaceuticals etc.</td>
</tr>
<tr>
<td></td>
<td>44: Soap, detergents etc.</td>
</tr>
<tr>
<td></td>
<td>45: Other chemical products</td>
</tr>
<tr>
<td><strong>Food &amp; Drink</strong></td>
<td>8: Meat</td>
</tr>
<tr>
<td></td>
<td>9: Fish, fruit and vegetables</td>
</tr>
<tr>
<td></td>
<td>11: Dairy products</td>
</tr>
<tr>
<td></td>
<td>14: Bread, baked products</td>
</tr>
<tr>
<td></td>
<td>16: Chocolate and confectionery</td>
</tr>
<tr>
<td></td>
<td>17: Other food products</td>
</tr>
<tr>
<td></td>
<td>18: Alcoholic beverages</td>
</tr>
<tr>
<td></td>
<td>19: Mineral waters and soft drinks</td>
</tr>
<tr>
<td><strong>Paper &amp; Publishing</strong></td>
<td>32: Pulp, paper and paperboard</td>
</tr>
<tr>
<td></td>
<td>34: Publishing and printing</td>
</tr>
<tr>
<td><strong>Manufactured Products</strong></td>
<td>23: Finished textiles</td>
</tr>
<tr>
<td></td>
<td>25: Carpets and rugs</td>
</tr>
<tr>
<td></td>
<td>28: Wearing apparel, fur</td>
</tr>
<tr>
<td></td>
<td>30: Footwear</td>
</tr>
<tr>
<td></td>
<td>46: Man-made fibres</td>
</tr>
<tr>
<td></td>
<td>47: Rubber products</td>
</tr>
<tr>
<td></td>
<td>48: Plastic products</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Product Category</th>
<th>Commodity Group</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Manufactured Products</strong> (continued)</td>
<td>49: Glass and glass products</td>
</tr>
<tr>
<td></td>
<td>60: Cutlery, tools etc.</td>
</tr>
<tr>
<td></td>
<td>77: Motor vehicles, trailers etc.</td>
</tr>
<tr>
<td></td>
<td>79: Other transport equipment</td>
</tr>
<tr>
<td></td>
<td>81: Furniture</td>
</tr>
<tr>
<td></td>
<td>82: Jewellery, musical instruments etc.</td>
</tr>
<tr>
<td></td>
<td>83: Sports goods, games and toys</td>
</tr>
<tr>
<td></td>
<td>84: Miscellaneous manufactured products</td>
</tr>
<tr>
<td></td>
<td>31: Wood and wood products</td>
</tr>
<tr>
<td><strong>Machinery &amp; Computers</strong></td>
<td>62: Mechanical machinery</td>
</tr>
<tr>
<td></td>
<td>66: Special purpose machinery</td>
</tr>
<tr>
<td></td>
<td>68: Domestic appliances</td>
</tr>
<tr>
<td></td>
<td>69: Office machinery and computers</td>
</tr>
<tr>
<td></td>
<td>71: Insulated wire and cable</td>
</tr>
<tr>
<td></td>
<td>72: Electrical equipment n.e.c.</td>
</tr>
<tr>
<td></td>
<td>73: Electronic valves and tubes etc.</td>
</tr>
<tr>
<td></td>
<td>74: TV, radio transmitters etc.</td>
</tr>
<tr>
<td></td>
<td>75: TV, radio receivers etc.</td>
</tr>
<tr>
<td></td>
<td>76: Medical, precision and optical instruments</td>
</tr>
<tr>
<td><strong>Utilities &amp; Construction</strong></td>
<td>52: Cement, lime and plaster</td>
</tr>
<tr>
<td></td>
<td>54: Basic iron and steel</td>
</tr>
<tr>
<td></td>
<td>55: Basic precious and non-ferrous metals</td>
</tr>
<tr>
<td></td>
<td>57: Structural metal products</td>
</tr>
<tr>
<td></td>
<td>85: Electricity</td>
</tr>
<tr>
<td></td>
<td>86: Gas, steam and hot water</td>
</tr>
<tr>
<td></td>
<td>87: Water supply</td>
</tr>
<tr>
<td></td>
<td>88: Construction</td>
</tr>
</tbody>
</table>
### Product Category

<table>
<thead>
<tr>
<th>Commodity Group</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transport &amp; Communication</strong></td>
</tr>
<tr>
<td>89: Sale, maintenance and repair of motor vehicles; retail sale of automotive fuel</td>
</tr>
<tr>
<td>90: Wholesale trade</td>
</tr>
<tr>
<td>91: Retail trade</td>
</tr>
<tr>
<td>92: Hotels and restaurants</td>
</tr>
<tr>
<td>93: Transport via railways</td>
</tr>
<tr>
<td>94: Other land transport; transport via pipelines</td>
</tr>
<tr>
<td>95: Water transport</td>
</tr>
<tr>
<td>96: Air transport</td>
</tr>
<tr>
<td>98: Post and courier services</td>
</tr>
<tr>
<td>99: Telecommunications</td>
</tr>
<tr>
<td><strong>Business Services</strong></td>
</tr>
<tr>
<td>100: Banking and financing</td>
</tr>
<tr>
<td>101: Insurance and pension funding</td>
</tr>
<tr>
<td>104: Letting of dwellings</td>
</tr>
<tr>
<td>106: Renting of machinery and equipment</td>
</tr>
<tr>
<td>107: Computer and related activities</td>
</tr>
<tr>
<td>108: Research and development</td>
</tr>
<tr>
<td>109: Legal activities</td>
</tr>
<tr>
<td>110: Accounting etc.</td>
</tr>
<tr>
<td>111: Business / management consultancy activities</td>
</tr>
<tr>
<td>113: Advertising</td>
</tr>
<tr>
<td>114: Other business services</td>
</tr>
<tr>
<td><strong>Public Services</strong></td>
</tr>
<tr>
<td>115: Public administration and defence</td>
</tr>
<tr>
<td>116: Education</td>
</tr>
<tr>
<td>117: Health care</td>
</tr>
<tr>
<td>119: Sewage and refuse disposal</td>
</tr>
<tr>
<td>121: Recreational, cultural and sporting activities</td>
</tr>
</tbody>
</table>
C. Interview Agenda

a) Occupational Role

1) What is your role in the university/department?

2) Does it relate to sustainable procurement? If so, then how?

b) Perspective on the utility of Carbon Footprint results

Utility and advantages

3) Do you think the results such as those displayed in the presentation would be useful for informing (or assisting) work related to your role? Explain your answer.

4) Are there any particular applications, plans or policies that you think the results could inform? If yes, then which?

Limitations and enablers

5) Are there any limiting factors in the results themselves or in your wider working environment that prevent them being of use in your role?

6) Can these factors be overcome? If yes, then how?

Final thoughts and conclusion

7) Is there anything you would do differently in your role having seen the results? If yes, then what? If no, then why?
### D. Coding structure

*Table 8.3. Coding structure from interview data*

<table>
<thead>
<tr>
<th>Code</th>
<th>Sub-Codes</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utility of CF</td>
<td>U1 - Figev</td>
<td>Results used principally as a means of providing proof/evidence to support current decision-making. Utility of figures and graphs mentioned.</td>
</tr>
<tr>
<td></td>
<td>U2 - Newinfo</td>
<td>Results provide new information from which easy-wins are identifiable. Desirability of this function is apparent especially at higher levels. Apparent that commodity group level is most useful.</td>
</tr>
<tr>
<td>Policy/Decision-making Relevance</td>
<td>P1 - Policyenv</td>
<td>Details of current policy environment relating to purchasing i.e. the sustainable procurement group</td>
</tr>
<tr>
<td></td>
<td>P2 - Highlevel</td>
<td>Results can be used to inform high level decision-making and sustainable procurement policy across the university</td>
</tr>
<tr>
<td></td>
<td>P3 - Lowlevel</td>
<td>Results can be used to inform low level decision-making across the university such as the Green Impact initiative</td>
</tr>
<tr>
<td>Barriers/Constraints</td>
<td>B1 - Culture</td>
<td>Culture, including resistance to environmental ideologies, politics preventing cooperation between departments, and lack of appropriate knowledge</td>
</tr>
<tr>
<td></td>
<td>B2 - Resources</td>
<td>Lack of resources, be it staff or money, and completion of service provision take precedence over environmental issues</td>
</tr>
<tr>
<td></td>
<td>B3 - Reality</td>
<td>Results constrained due to realities relating to the purchasing system and its structure, as well as infrastructure issues</td>
</tr>
<tr>
<td></td>
<td>B4 - Nonew</td>
<td>Cases where the results do not produce novel information for decision-making, and where proactive departments gain no additional insight</td>
</tr>
<tr>
<td></td>
<td>B5 - Tool</td>
<td>Limits relating to the actual tool and results, such as the insufficient mapping of supply chains, and the aggregation of commodity groups and sectors</td>
</tr>
<tr>
<td>Enablers/Drivers</td>
<td>E1 - Edupromo</td>
<td>Awareness raising and the promotion of Scope 3 within the university via education and training, and within purchasing consortiums</td>
</tr>
<tr>
<td></td>
<td>E2 - TopBot</td>
<td>Combined pressure from initiatives at the top and the bottom of university to overcome barriers</td>
</tr>
<tr>
<td></td>
<td>E3 - Mandate</td>
<td>Make addressing S3 emissions mandatory as opposed to optional as in the current situation</td>
</tr>
</tbody>
</table>
### E. GHG impacts of detailed commodity groups

**Tables 8.4 a, b and c. GHG impacts of commodity groups**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Commodity</th>
<th>Impact (t CO2-e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Electricity</td>
<td>51,609</td>
</tr>
<tr>
<td>2</td>
<td>UoL</td>
<td>28,303</td>
</tr>
<tr>
<td>3</td>
<td>Construction</td>
<td>17,218</td>
</tr>
<tr>
<td>4</td>
<td>Miscellaneous manufactured products</td>
<td>10,729</td>
</tr>
<tr>
<td>5</td>
<td>Special purpose machinery</td>
<td>6,509</td>
</tr>
<tr>
<td>6</td>
<td>Education</td>
<td>5,619</td>
</tr>
<tr>
<td>7</td>
<td>Office machinery and computers</td>
<td>5,417</td>
</tr>
<tr>
<td>8</td>
<td>Air transport</td>
<td>4,632</td>
</tr>
<tr>
<td>9</td>
<td>Other chemical products</td>
<td>3,952</td>
</tr>
<tr>
<td>10</td>
<td>Inorganic basic chemicals</td>
<td>2,928</td>
</tr>
<tr>
<td>11</td>
<td>Organic basic chemicals</td>
<td>2,564</td>
</tr>
<tr>
<td>12</td>
<td>Other business services</td>
<td>2,404</td>
</tr>
<tr>
<td>13</td>
<td>Publishing and printing</td>
<td>1,360</td>
</tr>
<tr>
<td>14</td>
<td>Meat</td>
<td>883</td>
</tr>
<tr>
<td>15</td>
<td>Dairy products</td>
<td>881</td>
</tr>
<tr>
<td>16</td>
<td>Hotels and restaurants</td>
<td>859</td>
</tr>
<tr>
<td>17</td>
<td>Gas, steam and hot water</td>
<td>845</td>
</tr>
<tr>
<td>18</td>
<td>Pulp, paper and paperboard</td>
<td>806</td>
</tr>
<tr>
<td>19</td>
<td>Fish, fruit and vegetables</td>
<td>787</td>
</tr>
<tr>
<td>20</td>
<td>Insulated wire and cable</td>
<td>742</td>
</tr>
<tr>
<td>21</td>
<td>Public administration and defence</td>
<td>737</td>
</tr>
<tr>
<td>22</td>
<td>Furniture</td>
<td>677</td>
</tr>
<tr>
<td>23</td>
<td>Water supply</td>
<td>626</td>
</tr>
<tr>
<td>24</td>
<td>Other land transport</td>
<td>594</td>
</tr>
<tr>
<td>25</td>
<td>Transport via railways</td>
<td>588</td>
</tr>
<tr>
<td>26</td>
<td>Business / management consultancy activities</td>
<td>576</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rank</th>
<th>Commodity</th>
<th>Impact (t CO2-e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>Plastic products</td>
<td>506</td>
</tr>
<tr>
<td>28</td>
<td>Post and courier services</td>
<td>466</td>
</tr>
<tr>
<td>29</td>
<td>Health care</td>
<td>454</td>
</tr>
<tr>
<td>30</td>
<td>Sewage and refuse disposal</td>
<td>438</td>
</tr>
<tr>
<td>31</td>
<td>Other food products</td>
<td>415</td>
</tr>
<tr>
<td>32</td>
<td>Insurance and pension funding</td>
<td>397</td>
</tr>
<tr>
<td>33</td>
<td>Electrical equipment n.e.c.</td>
<td>381</td>
</tr>
<tr>
<td>34</td>
<td>Mineral waters and soft drinks</td>
<td>356</td>
</tr>
<tr>
<td>35</td>
<td>Paints, varnishes etc.</td>
<td>344</td>
</tr>
<tr>
<td>36</td>
<td>Forestry products</td>
<td>320</td>
</tr>
<tr>
<td>37</td>
<td>Electronic valves and tubes etc.</td>
<td>298</td>
</tr>
<tr>
<td>38</td>
<td>Advertising</td>
<td>266</td>
</tr>
<tr>
<td>39</td>
<td>Chocolate and confectionery</td>
<td>206</td>
</tr>
<tr>
<td>40</td>
<td>Medical, precision and optical instruments</td>
<td>190</td>
</tr>
<tr>
<td>41</td>
<td>Finished textiles</td>
<td>189</td>
</tr>
<tr>
<td>42</td>
<td>Bread, baked products</td>
<td>183</td>
</tr>
<tr>
<td>43</td>
<td>Domestic appliances</td>
<td>170</td>
</tr>
<tr>
<td>44</td>
<td>Fertilisers etc.</td>
<td>157</td>
</tr>
<tr>
<td>45</td>
<td>Recreational, cultural and sporting activities</td>
<td>153</td>
</tr>
<tr>
<td>46</td>
<td>Pharmaceuticals etc.</td>
<td>139</td>
</tr>
<tr>
<td>47</td>
<td>Cutlery, tools etc.</td>
<td>111</td>
</tr>
<tr>
<td>48</td>
<td>Alcoholic beverages</td>
<td>103</td>
</tr>
<tr>
<td>49</td>
<td>Letting of dwellings</td>
<td>101</td>
</tr>
<tr>
<td>50</td>
<td>Soap, detergents etc.</td>
<td>93.5</td>
</tr>
<tr>
<td>51</td>
<td>Wholesale trade</td>
<td>86.4</td>
</tr>
<tr>
<td>52</td>
<td>Basic iron and steel</td>
<td>82.8</td>
</tr>
<tr>
<td>53</td>
<td>Wearing apparel, fur</td>
<td>77.8</td>
</tr>
</tbody>
</table>
A Worthy Investment? Evaluating the Utility of Carbon Footprints for Informing Environmental Policy Within Organisations

c) Rank | Commodity | Impact (t CO2-e)  
--- | --- | ---  
54 | Legal activities | 63  
55 | Glass and glass products | 60.6  
56 | Accounting etc. | 58.9  
57 | Basic precious and non-ferrous metals | 52.2  
58 | Retail trade | 52  
59 | Structural metal products | 50.7  
60 | Research and development | 47  
61 | Jewellery, musical instruments etc. | 44.5  
62 | Retail sale of automotive fuel | 42.9  
63 | Cement, lime and plaster | 35.1  
64 | TV, radio receivers etc. | 29  
65 | Computer and related activities | 26.8  
66 | Carpets and rugs | 20.3  
67 | Mechanical machinery | 19.3  
68 | Motor vehicles, trailers etc. | 17.5  
69 | Footwear | 8.94  
70 | Rubber products | 8.69  
71 | Sports goods, games and toys | 7.52  
72 | Man-made fibres | 6.59  
73 | Aggregates (stone, sand, gravel, etc.) | 6.26  
74 | Other transport equipment | 5.14  
75 | Renting of machinery and equipment | 4.28  
76 | Telecommunications | 3.59  
77 | TV, radio transmitters etc. | 2.49  
78 | Water transport | 1.82  
79 | Wood and wood products | 0.14