Carbon Footprint of Northern Rail

CenSA
Centre for Sustainability Accounting

GHD

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CenSA and GHD

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Research Report

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Introduction

Scope of this report

A greenhouse gas (GHG) footprint has been calculated for Northern Rail, including both the direct GHG emissions generated by Northern Rail's trains and premises and those that are generated elsewhere in the production of energy, infrastructure, goods or services purchased by Northern Rail (supply chain emissions). This report provides an analysis of this footprint, and will be used to help Northern Rail develop an understanding of the structure of its footprint and develop improvement measures.

In Northern Rail's Environmental Sustainability Strategy published in 2008, there was a clear commitment to understand both the direct and indirect carbon emissions associated with Northern Rail. This full carbon footprint report meets this commitment.

Background

Businesses are increasingly aware of the issue of climate change and want to understand what this means for their company. It is generally accepted that the rail industry delivers mobility that has lower direct emissions per passenger kilometre than many other transport modes, most notably air and car travel. Rail travel has an important role to play in the move towards a low carbon economy for the UK, and Northern Rail is a key part of this. In order to maintain its position as a provider of low carbon mobility solutions, the railways must continue to enhance its environmental performance and seek continuing ways to reduce its carbon footprint, and play its part in encouraging other transportation sectors to reduce theirs.

An important first step is to quantify the current GHG footprint, in order to identify opportunities for reduction, set appropriate targets and track progress. One of the main difficulties for any organisation in developing a credible GHG footprint is how to deal with embodied[1], or supply chain, emissions (i.e. those emissions made by suppliers and suppliers of suppliers, etc. in the delivery of products and service to the organisation). As these emissions are difficult to measure, conventional footprints have excluded them, or only included a small minority, focusing instead on direct emissions and sometimes purchased electricity, which are easier to measure but often make up only a relatively small proportion of the overall footprint, particularly in service industries.

These problems are overcome by the extended life-cycle approach adopted in this study, which is the first commercially available technique for capturing emissions made throughout the entire network of supply chains, respective of the country of production.

[1] In this report we use the terms 'embodied' and 'embedded' as synonyms.

Methodology

Overview of the Approach

The calculation model used in this project is based on an environmentally extended input-output life-cycle analysis (EIO-LCA) at the national (UK) level, using official data from the Office of National Statistics (ONS) "National (economic) Accounts" and ONS "Environmental Accounts". This means that all results all fully consistent with standard economic and environmental accounting and fully comparable amongst each other. The sophisticated methodology is based on 10 years of scientific research which has been field-tested over five years, has been published in numerous journal articles, and has been incorporated into a software tool named Bottomline[3] (www.bottomline3.co.uk).

The comprehensive nature of EIO-LCA means that the whole (UK) economy, including imports and exports, are the system boundary, which is a major advantage when developing complete, holistic GHG footprints. Conventional footprinting assessments introduce artificial boundaries to GHG accounting, with this truncation of the system boundary often leading to significant underestimations of the true impact. The EIO-LCA methodology used in this assessment overcomes these truncation errors and – as the analysis shows – results in some enlightening revelations regarding the 'embodied' carbon within rail transport.

This approach makes the assumption that Northern Rail's individual suppliers and supply chains are representative of their respective industry group classifications. Whilst this enables a scientifically robust and replicable quantification of embedded[1] emissions, the model results can only be considered estimates and should not be mistaken for real measurements.

A detailed description of the methodology employed is provided in Appendix A.

Terminology

Table 1: Terminology used in this report

Phrase	Definition
GHG footprint Carbon footprint	A measure of the exclusive total amount of greenhouse gas emissions that is directly and indirectly caused by an activity or is accumulated over the life stages of a product. In this report, GHG include the three major contributors to climate change: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). CH_4 and N_2O are important because they have a global warming potential greater than CO_2 (21 and 310 times respectively (DEFRA 2007)). The combined global warming potential of CO_2, CH_4 and N_2O is expressed in this report as a GHG footprint and is reported in CO_2 equivalent mass units (kg, t, kt CO_2-e) The term 'GHG footprint' and 'carbon footprint' have been used interchangeably in this report.
Scope 1 emissions	Following the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) Greenhouse Gas Protocol definitions (WRI and WBCSD 2004) as well as DEFRA's "Draft guidance on how to measure and report your greenhouse gas emissions" (DEFRA 2009), Scope 1 includes GHG emissions directly occurring from sources that are owned or controlled by the organisation. This includes emissions from gas oil burnt by trains for locomotive power, from natural gas burnt on site and from fuel consumed by vehicles operated by Northern Rail personnel in the course of business activities.
Scope 2 emissions	GHG emissions from the generation of purchased electricity consumed by the organisation. Scope 2 emissions physically occur at the facility where electricity is generated.
Scope 3 emissions	All other indirect GHG emissions that are a consequence of the activities of the company, but occur from sources not owned or controlled by the company. In this project we mainly assess upstream (i.e. manufacture and supply) Scope 3 emissions. We exclude non-applicable downstream emissions (e.g. use/disposal of sold products) and emissions resulting from the private activities of employees (which include travel to and from work).
Direct emissions	On-site or internal emissions, directly equivalent to Scope 1.
Indirect emissions	Off-site, external, embedded, upstream or downstream emissions. Equivalent to the sum of Scope 2 and 3.
Embedded emissions Embodied emissions	Emissions associated with the manufacture and supply of a product or service purchased by the organisation (also called supply chain emissions). In this report we use the terms 'embodied' and 'embedded' as synonyms.

Data inputs

Two types of input data have been used in this assessment:

- Expenditure data (from financial accounts)
- Fuel used directly by Northern Rail (including gas for heating and gas oil for locomotive power)

Expenditure data (extracted from financial accounts) were provided for the 2007 and 2008 financial years, giving the opportunity to create comparative footprints across two consecutive years. The expenditure data allowed the embedded GHG emissions associated with the procurement of all goods and services to be accounted, and included costs associated with the infrastructure provision. The expenditure categories were taken from Northern Rail's detailed profit and loss account and were matched to the standard 76 sector categories in Bottomline[3].

Data for direct energy consumption included fossil fuels needed for heating and powering vehicles. Consumption data on the fuel used by trains were provided for both years.

Scope of the analysis: what is included and what is excluded

The carbon footprint analysis in this report follows the 'Best Practice' procedure outlined in DEFRA's "Draft guidance on how to measure and report your greenhouse gas emissions" from 5 June 2009 (DEFRA 2009). It is also consistent with the Greenhouse Gas Protocol Corporate Accounting and Reporting Standard developed by the World Resources Institute and the World Business Council for Sustainable Development (WRI and WBCSD 2004). Relevant emissions from all Scopes 1, 2 and 3 are included. Some downstream Scope 3 emissions are not applicable as Northern Rail only sells services to customers but not products. Therefore, there are no emissions associated with the distribution, use and disposal of sold products. The emissions from using NR trains ("sold services") are already included in Scope 1. Emissions from the disposal of waste and waste water from direct operations of NR are included (via expenditure on refuse and sewage services).

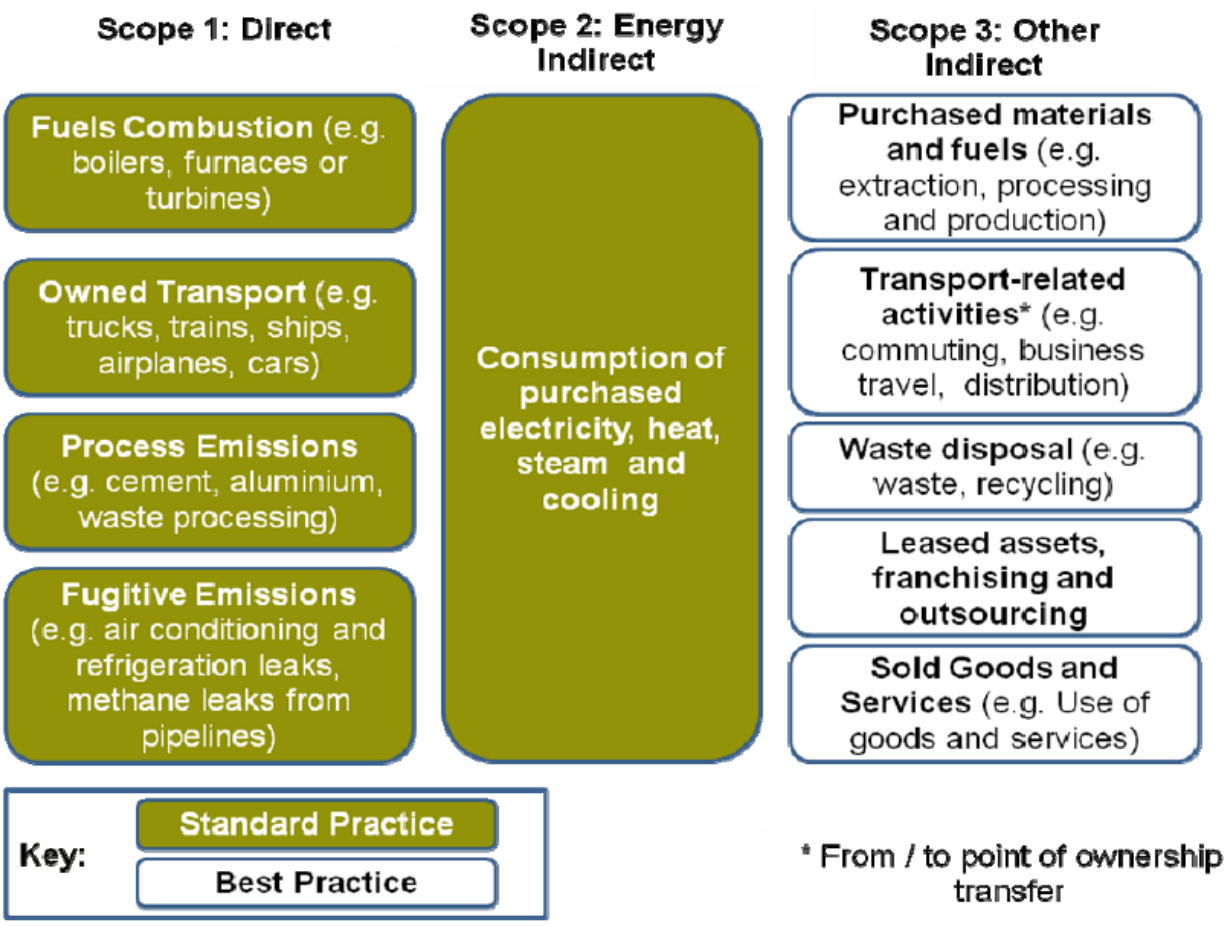

Figure 1: Scopes of carbon footprint emissions associated with the operations of a company (DEFRA 2009, p.15)

In this project we exclude Scope 3 emissions associated with private activities of Northern Rail employees which include travel to and from work; so employee commuting is excluded. Tax spending is excluded as we consider the ways in which tax monies are spent to be outside of Northern Rail's influence, and the responsibility of government.

Every other item of expenditure by Northern Rail has been included in the analysis.

The Issue of Responsibility and Double Counting

The GHG footprint analysis presented in this report is based upon the full impacts associated with Northern Rail's operations, meaning that the full extent of GHG emissions embodied within the supply chain. This does not imply that Northern Rail is legally responsible for the complete supply chain emissions or even has the influence to reduce emissions along the supply chain.

Clearly, the direct emissions of one company are the indirect impacts of another company. For example, a power plant operator reports direct GHG emissions based on on-site coal or gas consumption, while purchasers of electricity report them as indirect emissions. Should both the power plant operator and the electricity consumer report the full extent of emissions in the same assessment, they will be double counted. The focus of this assessment, however, is not to develop a

national total of GHG emissions, but rather to examine Northern Rail's total footprint to understand the contributing factors and develop ways in which it can be reduced. Therefore, the approach of allocating full responsibility has been adopted as it provides a measure of the total emissions associated with rail travel. For a further discussion of this issue please see Lenzen et al. 2007 and Wiedmann and Lenzen 2008.

Results

Overview of Footprint

The GHG footprint associated with Northern Rail for the 2007 financial year was just less than 300,000 t CO_2-e. Over 96% of this was associated with carbon dioxide, with other greenhouse gas emissions playing a relatively small role (around 4%). In 2008, the footprint had grown marginally to 308,000 t CO_2-e, an increase of 2.7%. Again, the results for 2008 were dominated by carbon dioxide.

The results presented below are broken down by the GHG Protocol reporting categories and high-level categories requested by Northern Rail (of Procurement, Train Use and Infrastructure).

GHG Protocol categories breakdown

Figure 1 below shows the results for the 2007 and 2008 financial years, organised by the categories used within the Greenhouse Gas Protocol. Refer to Table 1 for definitions relating to Scope 1, 2 and 3 emissions.

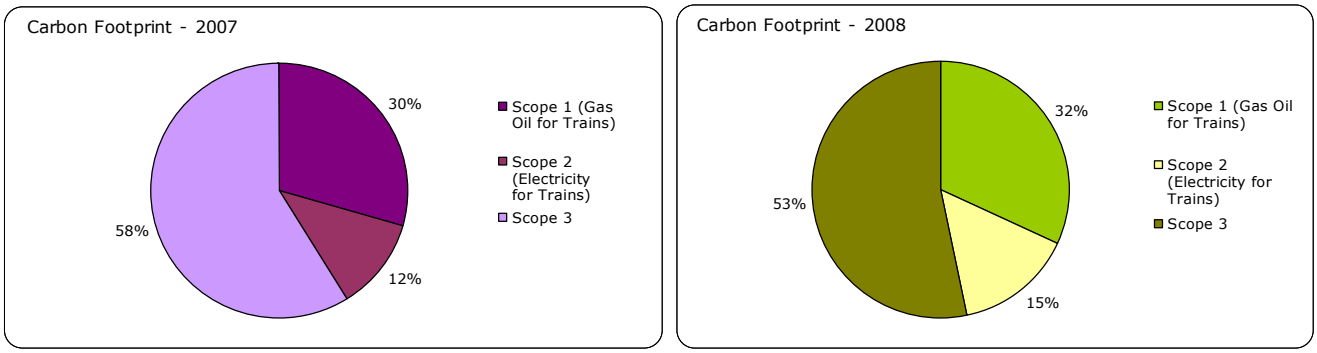

Figure 2: Northern Rail's GHG Footprint (Scopes 1, 2 and 3)

Scope 1 emissions account for between 30 and 32% of the total emissions. These emissions are almost entirely associated with the use of gas oil for train fuel. Scope 2 emissions (purchased electricity) account for between 12 and 15% of total emissions. This is predominately electricity to power trains. Scope 3 emissions account for between 53 and 58% of the total carbon footprint. This includes all the embodied carbon along the supply chains of the products and services purchased by Northern Rail.

Fuel, Network Rail and procurement breakdown

Figure 2 shows the results broken down by the following categories:

- Carbon footprint of energy used to power trains (including both gas oil and electricity). These include Scope 1 and Scope 2 emissions.
- Carbon footprint of Northern Rail's contribution towards railway infrastructure, provided by Network Rail. These emissions are part of Scope 3 emissions.
- Carbon footprint associated with all other expenditure by Northern Rail. These emissions are Scope 2 and 3 emissions.

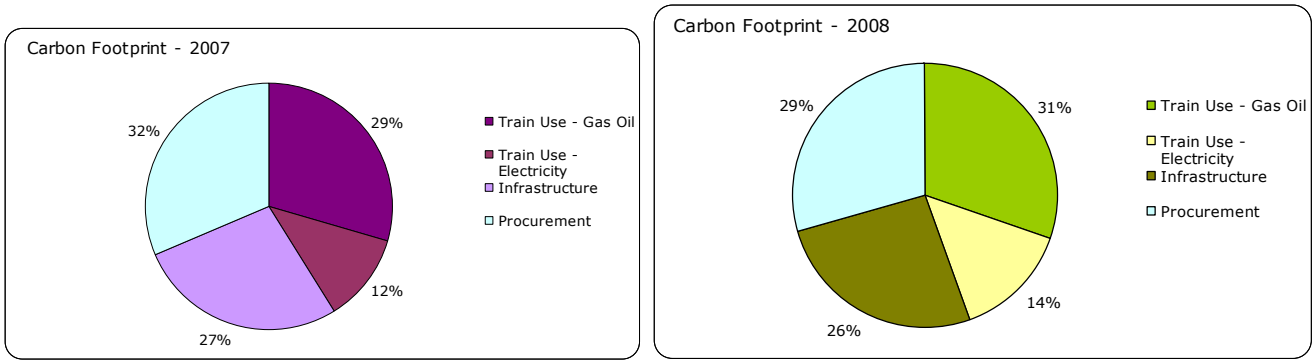

Figure 3: Carbon Footprint Broken Down by Activity

Out of the three categories, energy for trains is the most significant (~41%). However, by only considering the energy use of trains, ~59% of the carbon footprint is not considered. The carbon footprint of providing the infrastructure for trains is considerable, accounting for a further 28%[2]. The remainder (31%) is associated with Northern Rail's business expenditure required to operate its trains. This incorporates the full range of business functions from hiring rolling stock and printing timetables to maintaining the necessary corporate insurance.

Benchmark Performance

Benchmarking enables entities of disparate qualities to be compared against one another. The performance of passenger railways is often benchmarked by comparing a performance indicator, such as GHG emissions, on a per passenger kilometre basis (passenger km).

Northern Rail's total GHG footprint increased between 2007 and 2008 by 2.7%, however it is also noted that the total quantity of passenger journey (passenger km) also increased over this period. Figure 4 below compares the benchmarked (or normalised) performance across the two years.

[2] Please refer to the discussion regarding the carbon footprint associated with Network Rail later on in Section 3 of this report. This value is not necessarily a representative indication of the carbon footprint associated with providing and maintaining the infrastructure that Northern Rail requires to operate its services.

Conventionally, measures of GHG emissions per passenger km within the rail industry have been based only on the emissions associated with the energy (i.e. diesel/gas oil and electricity) used to power the trains. As highlighted above, this component only accounts for ~41% of Northern Rail's total footprint, when embodied emissions are also considered to provide a complete footprint.

Figure 4 compares different measures of the benchmarked GHG emission performance: firstly when only train energy use is included; secondly with infrastructure embodied emissions added; and lastly with all embodied emissions included. The first measure (train energy only) is the most suitable for comparison against standard industry measures. Figure 4 is cumulative.

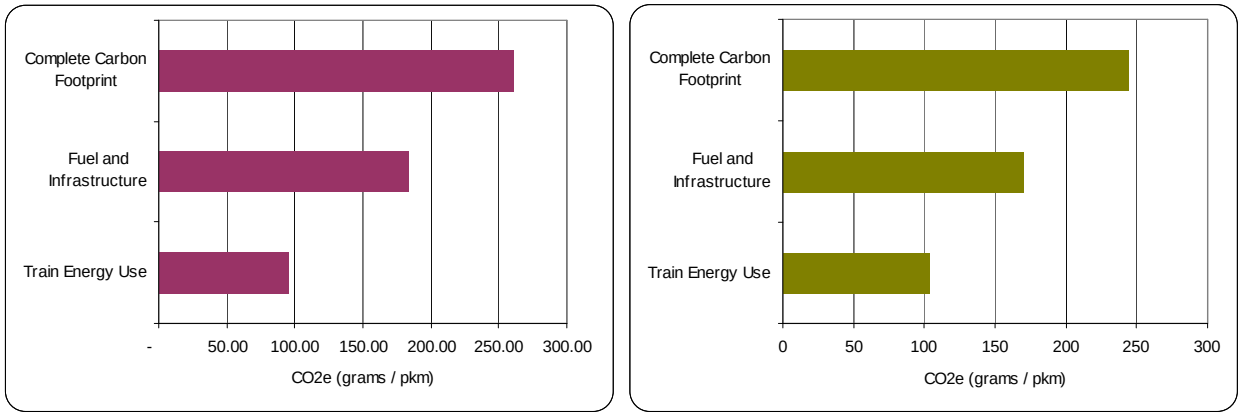

Figure 4: Comparison of different measures of emissions per passenger km

The average carbon footprint for train energy use was between 98 and 102 grams CO_2-e/passenger km[3]. The variation between the two years is within error margins, indicating that it is reasonable to conclude that there was no or little change in the train energy-based footprint of delivering one passenger km by Northern Rail in 2007 and 2008. In Figure 5, the performance of Northern Rail is compared to the direct CO_2 emissions of other transport modes.

[3] Two sources of energy are used to power trains operated by Northern Rail, these being gas oil and electricity. In this analysis it is assumed that the electricity is provided by the national grid and therefore adopts the national fuel mix for producing electricity. ONS Environmental Accounts data were employed to estimate the carbon output of gas oil.

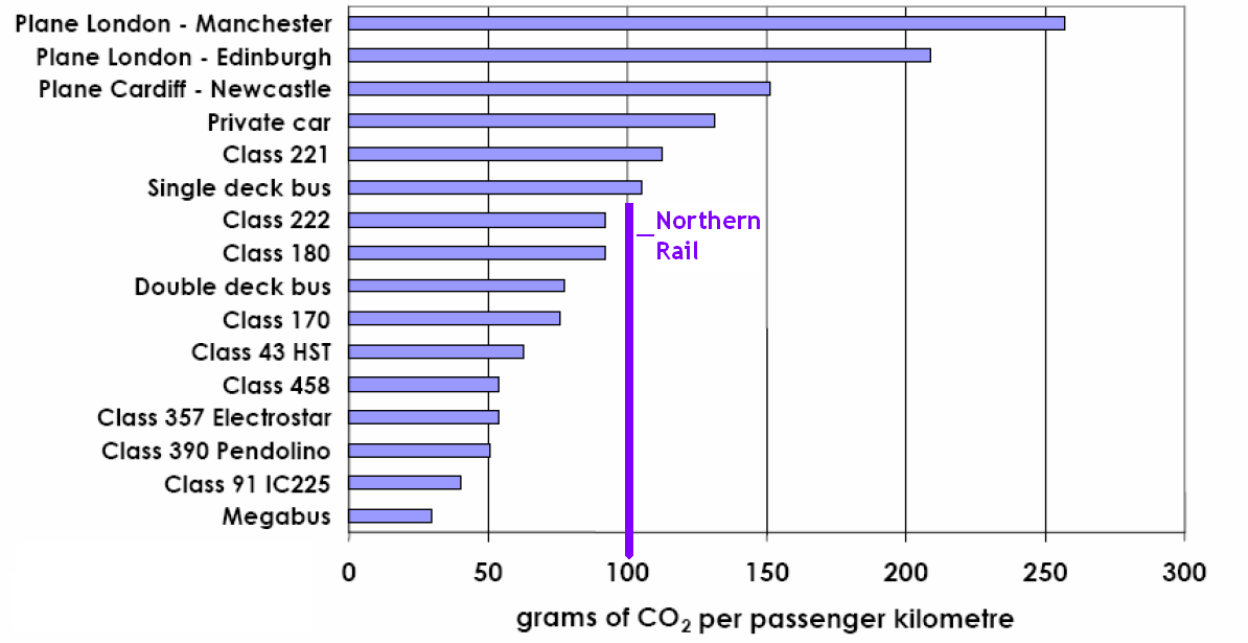

Figure 5: Relative direct carbon dioxide emissions of rail compared to other modes
(DfT 2007, p. 113; updated figure to replace Figure 11.1 in the rail white paper Delivering a Sustainable Railway and Figure 4.2 in the Rail Technical Strategy)

There is a notable decrease in the normalised carbon footprint associated with Northern Rail's infrastructure and procurement needs between 2007 and 2008, resulting in a reduced impact per passenger km. This is discussed in greater detail later in this Section.

To support the result above, a benchmark relating to the carbon footprint per £ spent by Northern Rail has been presented below in Figure 6.

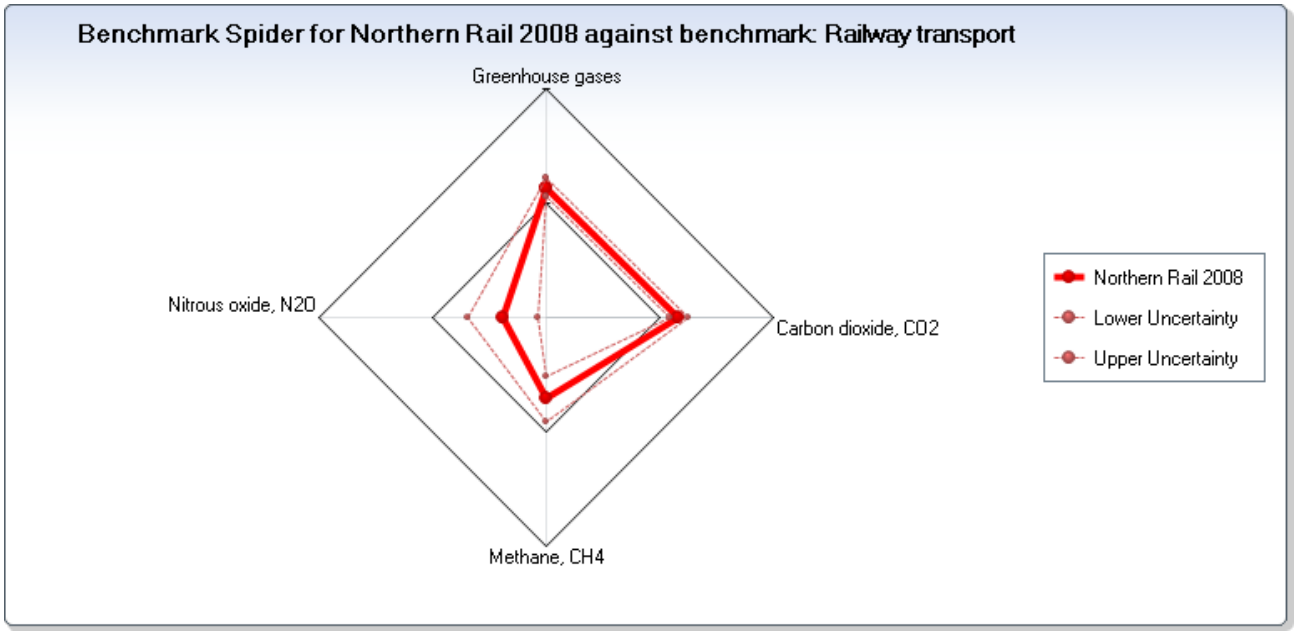

Figure 6: **Northern Rail 2008 – Greenhouse Gas Emissions per £ spent** (the spider diagram shows the emission intensity of NR compared to that of the whole UK railway sector. The red line shows the values for three GHGs as well as the total. The regular polygon in the centre of the diagram (black line) shows the average emission intensity per £ of the UK railway sector, allowing a benchmark comparison. GHG footprints lower than the average are closer to the centre, while higher footprints are positioned closer to the outside boundary ("the smaller the area encircled by the red line, the better").

The greenhouse gas emissions per £ spent for Northern Rail is between 20% and 40% higher than the average impact of the rail sector spending a £. This is a comparison with any company that it categorised as belonging to the "rail sector". This includes infrastructure (Network Rail), train operating and other supporting companies.

In terms of comparability, the fact that the “complete” carbon footprint has been assessed is important. Northern Rail is the first TOC to undertake this analysis and therefore cannot directly compare the results with others. The analysis in this report should be seen as a vehicle to enable Northern Rail to gain a greater understanding of the carbon emissions of their operations and not for comparisons. The information above can be used to give an indication of how Northern Rail compares with the average impacts of the sector.

The situation is changing fast and it will not be long before clear and complete comparisons of carbon footprint are possible. Already the National Health Services, education sector and over 15 companies are using this approach.

Train Energy Use Footprint

Traction energy for trains operated by Northern Rail is supplied by gas oil and electricity. The absolute GHG footprint associated with energy use for train operation was marginally over 143,000 t CO_2-e. The use of gas oil was responsible for 69% of this, and the remainder was associated with the use of electricity.

In order to estimate the emissions associated with the supply of electricity, it is standard practice to use DEFRA's conversion factor, which is published as part of their guidance for businesses on GHG reporting. However, this figure underestimates the associated GHG emissions because it does not take into account the embodied emissions associated with generating electricity (instead, it only accounts for direct emissions occurring from the power plant). In reality, electricity generation relies on numerous supply chains, just like any other product or business. Therefore, in estimating the emissions associated with electricity given above, we have used the conversion factor that accounts for the full footprint (i.e. direct emissions plus embodied emissions), which is approximately 25% higher than the factor published by DEFRA. When making comparisons with other train operators' estimates of emissions from electricity, this should be taken into account. For a further explanation of electricity conversion factors please refer to appendix A.

Infrastructure Footprint

The GHG footprint associated with Network Rail relates to Northern Rail's 'share' of the GHG emissions associated with the provision, maintenance and operation of the rail infrastructure. Bottomline[3] was used to calculate this footprint, using financial transactions to map economic activity and assign associated emissions. To enable this assessment, two additional assumptions were made:

- The fiscal transaction between Northern Rail and Network Rail is representative of the Northern Rails 'share' of the rail network. In other words, the amount that Northern Rail paid Network Rail is a true representation of the cost of providing the service that Network Rail provided Northern Rail;
- The allocation within Bottomline[3] for the expenditure associated with Network Rail is allocated to the rail sector and therefore represents a carbon footprint associated with the sector average and not specifically Network Rail.

In reality, it is expected that both of the above assumptions will result in some error, as discussed below:

- The amount that Northern Rail pays Network Rail is not directly governed by the service provided, but is a product of the gap in funding between Network Rail's *reasonable costs* determined by the Office of Rail Regulation (ORR) and all its other forms of income outside of track access charges. This funding gap is then met by the Train Operator whose charges are determined in a number of ways described in the Network Statement;
- Bottomline[3] uses complex economic models to estimate how expenditure propagates through an economy. In the case of Network Rail, a more accurate estimation of the carbon footprint would be derived if Network Rail's expenditure was mapped based upon company financial

information, rather than allowing the model to map the expenditure as was done in this assessment.

It was beyond the scope of this assessment to complete a detailed assessment of Network Rail's GHG footprint, and it will only be possible to accurately estimate Northern Rail's 'share' of the rail infrastructure footprint if such an assessment is completed.

The GHG footprint associated with Network Rail in this assessment should therefore be seen as an indication of the magnitude of the likely footprint, and it should be acknowledged that the footprints calculated for train use and procurement are likely to be more accurate.

The 'take home' message of this portion of the assessment is that significant GHG emissions are associated with the provision, maintenance and operation of the rail infrastructure. Many traditional rail footprinting studies have not considered this significant contributor, and as such should be viewed as underestimating the real emissions associated with rail travel.

Procurement Footprint

In terms of absolute impact between 2007 and 2008, there is no notable variation in the emissions, accounting for 31% of the total GHG footprint in both years. The normalised emissions (i.e. emissions per passenger km) indicate a reduction in emissions, suggesting that the reduction in the normalised emissions is attributable to increased operational efficiency, largely realised through increased passenger throughput while maintaining a similar expenditure profile.

Figure 7 below gives a detailed breakdown of the procurement categories. These 16 categories make up 80% of the procurement footprint.

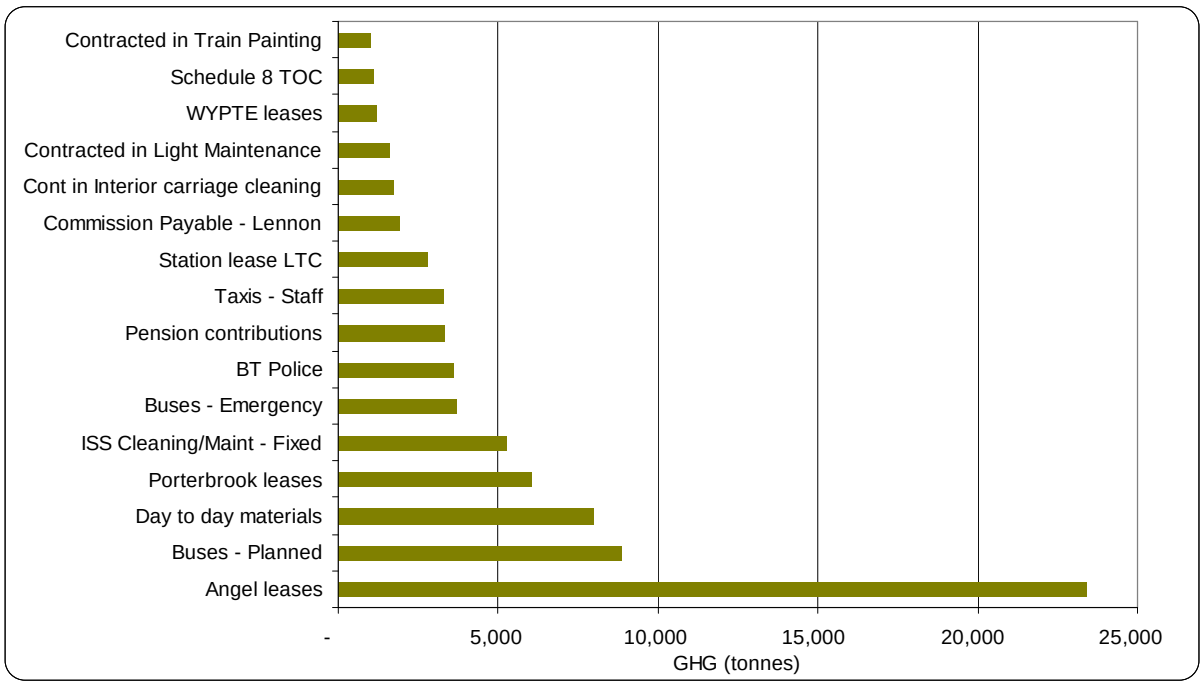

Figure 7: Breakdown of Northern Rail's Procurement Footprint

The embodied energy in the construction of the rolling stock ("Angel leases") has by far the most significant impact, accounting for 25% of the procurement footprint. This is followed by a number of categories with a similar carbon footprint; these being the use of buses, day to day materials for train maintenance as well as cleaning. Together these three categories account for a further 25%.

In terms of where the carbon footprint occurs along the supply chain, Figure 8 demonstrates the "layers" in the supply chain for the total impact of Northern Rail. 'Layer 2' is representative of all direct suppliers to Northern Rail, 'Layer 3' are the suppliers of those suppliers and so on.

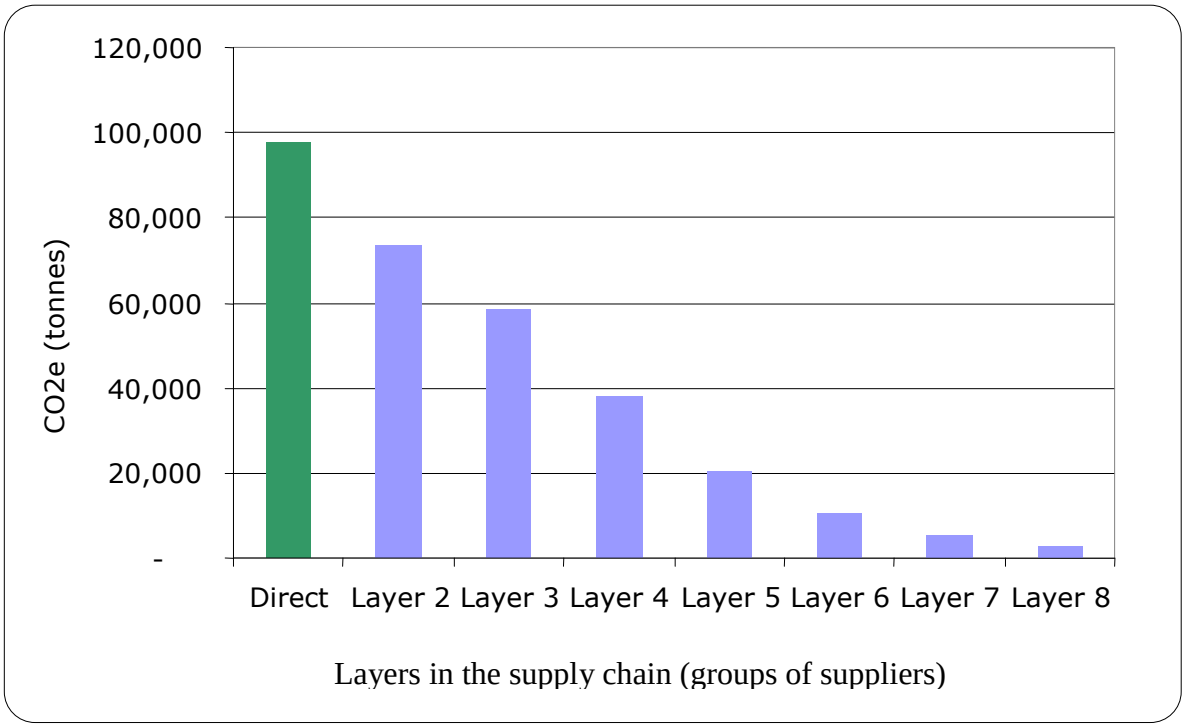

Figure 8: Carbon Footprint through the supply chain (production layers in the economy)

Over 55% of the total carbon footprint of Northern Rail occur either directly (onsite emissions) or are associated with a direct supplier to Northern Rail.

Again, many traditional rail footprint analyses have not considered the full scale of emissions embodied in procurement due to the introduction of artificial system boundaries. They should therefore be viewed as underestimating the real emissions associated with rail travel.

Conclusions and Recommendations

Our conclusions and recommendations are set out below, with recommendations highlighted in **bold** text. The issue of carbon and introducing mitigation strategies is not new to Northern Rail. The added value of this report relates to the inclusion of scope 3 emissions for the first time. Therefore, the majority of the recommendations focus on reducing scope 3 emissions.

Northern Rail already appreciates many of the key benefits to in reducing their GHG footprint. There is a reputational benefit which can be used in marketing a company's goods and services. In the case of Northern Rail this benefit already exists in part as rail is perceived to be an 'environmentally friendly' travel mode. The benefit from a marketing perspective that will accrue if the recommendations within this report are followed is that Northern Rail will be able to report improvements to their GHG emissions and the ability and scope to reduce these emissions is increased by the assessment methodology used in this study. The marketing benefit of claiming GHG reductions from the supply chain is well recognised in the retail sector and often the effort required to adjust procurement strategies to achieve these reductions in not great.

Further benefits from GHG reduction actions are often realised on the bottom line. Many of the suggested actions strive to use resources more efficiently, often leading to cost reduction. GHG reduction strategies sometimes identify aspects that traditional 'cost management' has missed.

It should be noted that there is an issue in using the GHG footprint generated in this assessment as the footprint is based upon a holistic approach, without the artificial imposition of system boundaries. Other studies only consider a limited aspect of the total footprint. If utilising a comparison of footprints within Corporate Reporting it is therefore important to compare data on a 'like for like' basis. Using the data within this assessment, it is possible to generate a GHG footprint that can be compared to other studies.

General Recommendations

A key benefit of quantifying the supply chain emissions is that this gives an insight into the areas (other than its own direct emissions) where Northern Rail could exert influence on its supply chains to reduce carbon emissions. We therefore recommend that Northern Rail:

- **Develop a prioritised action plan for reducing Northern Rail's GHG footprint.** We suggest this involve a workshop process to identify potential reduction measures and assess these against potential size of impact, potential cost, relative ease of implementation and likelihood of success.

Measures to reduce supply chain emissions should be focused on GHG 'hotspots' within the supply chains, in order to generate maximum reductions for least cost/effort. The information provided in this report clearly acts a strong list to concentrate effort. Therefore:

- **The potential for reducing supply chain emissions should be investigated in more detail to establish the GHG hotspots within the supply chains where Northern Rail should focus its emission reduction efforts and where they have greatest influence.**

Environmental improvement initiatives run the risk of being short term unless they are embedded within business processes. Many organisations adopt an Environmental Management System (EMS), which provides a mechanism for formalising environmental programmes and delivering continuous improvement. Therefore we recommend that Northern Rail:

- **Embed the GHG reduction measures within business processes, for example under Northern Rail's existing Environmental Management System. However, this should not be purely about process but must establish sound reduction targets.**

In order to measure its progress in reducing its GHG footprint, Northern Rail will need to conduct periodic reviews, involving a staged, iterative process. Such reviews will also enable Northern Rail to ensure its priorities continue to be aligned to new developments, such as new technologies or changing stakeholder expectations, for example. We therefore recommend that Northern Rail:

- **Undertake regular reviews on a one to two year basis to track the progress of Northern Rail's GHG footprint reduction programme and to highlight any new or emerging priorities.**

A secondary value to Northern Rail of this analysis is its ability to raise awareness of sustainability issues throughout the organisation. Through robustly estimating the scale and nature of embodied GHG emissions, the sustainability impacts of purchases not typically associated with climate change in the mainstream media (such as professional services and pension schemes) can be readily communicated to non-sustainability professionals. We therefore recommend that Northern Rail's sustainability team:

- **Use this report to raise awareness of Northern Rail's wider sustainability impacts to all staff, particularly those in senior roles whose decisions have the greatest impact.**

This study did not take the entire Scope 3 emissions into account by not including staff commuting. While it is clearly personal choice on how someone gets to work, Northern Rail can influence individual decisions by considering home working policies, the position of offices and incentive systems. Therefore:

- **Include the full Scope 3 emissions by considering the GHG footprint of staff commuting.**

Scope 1 and 2 Emissions

Reduce rolling stock emissions

The single biggest contributor to Northern Rail's carbon footprint is the emissions associated with powering trains (41% of total). Northern Rail are already aware of the significant opportunities for improving the performance of the rolling stock. It is clear from the Environmental Sustainability Strategy that Northern Rail have already undertaken a review and prioritised measures to improve the efficiency of the rolling stock, a key step in reducing emissions. In addition to this many of the recommendations that we would suggest are being considered. The list below outlines these measures in relation to reducing the carbon footprint.

- **Review and prioritise measures to improve the efficiency of the rolling stock. Measures that could be taken include:**

Re - engineering the units, i.e. installing new engines. Modern designs can considerably improve efficiency.

Implementing regenerative braking technology, a solution currently being implemented elsewhere in the industry. Regenerative breaking involves recovering energy from trains during braking and either returning this energy to the system, or in the case of diesel traction, charging batteries, which then contribute to the energy used to power the train.

Driver training to increase fuel efficiency. This could also be linked in to work currently being undertaken by RSSB on a speed management system to advise drivers on the optimum speed to maximise fuel efficiency.

Investigating options for improving the efficiency of air conditioning units and lighting, etc. on trains.

- **Consider the use of greener fuels (e.g. biodiesel). There is currently concern over the impacts of some biofuel production on biodiversity and communities. However, sustainable sources are available and a careful selection of previously appraised and certified sources for biofuels could present an opportunity to significantly reduce the fuel footprint.**

Influence the energy industry

The rail sector is a large consumer of electricity and is in a strong position to influence the electricity supply industry. We recommend that where possible Northern Rail:

- **Strongly support renewable energy for electricity generation**. Whilst the reduced emissions from green electricity tariffs cannot currently be claimed by consumers under government guidelines[4] and whilst there is significant variation in the percentage of renewables that provide green energy tariffs, there are other ways to

[4] Note this issue is currently being debated via consultation on the draft Carbon Reduction Commitment legislation, and therefore may change depending on the outcome of the consultation. The statement is correct at the time of writing.

support renewable energy. Northern Rail could influence Network Rail's future decisions in relationship to the provision of electricity. The key factor is the retirement of tradable quotas.

Improve quality of footprint data

Northern Rail should adopt a policy of continually improving the visibility and quality of its carbon footprint data. We therefore recommend that Northern Rail:

- **Review footprinting data quality, and establish a continuous improvement action plan, prioritizing the most significant absolute components of the overall footprint.** As a general starting point, this should include checking that fuel and energy consumption data are based as far as possible on direct measurement (e.g. meter readings) that relate solely to the fuel and energy consumption attributable to Northern Rail.

Incentivise energy savings

In an ideal situation, energy users pay only for the energy they use, so each user is financially incentivised to reduce energy use. However, it is common for this incentive to be lost, for example due to flat rate payment arrangements, lack of link-up between procurement and energy management roles, etc. To this end we recommend that Northern Rail:

- **Move to ensure they pay only for the fuel and energy used (based on metered supply), and that the link between cost and energy use is clear.**
- **Consider the use of smart electricity meters to identify real-time power use of electrical appliances.**

Scope 3 Emissions

Influence the rail sector

Significant emissions are associated with the provision of the rail infrastructure through Network Rail. We therefore recommend that Northern Rail:

- **Encourage Network Rail to complete a GHG footprinting study incorporating a detailed assessment of Scope 3 emissions. The findings of this assessment should be incorporated in future footprinting studies completed by Northern Rail.**
- **Encourage Network Rail to implement an emissions reduction strategy.**
- **Encourage Network Rail to be proactive, open and transparent with regards to the assessment and mitigation of GHG emissions.**
- **Support a wider assessment across the UK Rail Sector.**

Reduce supply chain emissions

All of Northern Rail's expenditure has an associated embedded GHG footprint. The results of this study show that these embedded emissions are a significant proportion of Northern Rail's total footprint. We recommend that Northern Rail:

- **Ensure embodied emissions are considered in all procurement decisions starting with the "Big Hitters".**
- **Ask suppliers to:**
  - Provide information about GHG emission embedded in their products and services
  - Explain any emissions reduction measures they have implemented
- **Move towards selecting suppliers based on their sustainability performance, key aspects of which should be, in order of priority:**
  1: Lowest embedded GHG emissions
  2: (Where there is no information on 1)
  Highest level of maturity in GHG accounting and reduction
  3: (Where there is no information on 1 or 2)
  Strength of commitment to reducing GHG emissions

Reduce the impact of business travel

Business travel often accounts for a significant component of a carbon footprint, and is a key area where reductions can be made through influencing employees' behaviour. We therefore recommend that Northern Rail:

- **Collate business travel information and use this to calculate the associated GHG emissions.**
- **Implement measures to reduce the amount of business travel undertaken, such as promoting teleconferencing, car sharing, optimising single business trips to achieve multiple objectives, and implementing video conferencing facilities.**
- **Ensure that the GHG emissions associated with business travel are always considered when selecting the mode of travel (e.g. rail, road, air) and recommend a mode hierarchy to staff (e.g. rail before road, where possible).**

Conserve resources (consumables)

By reducing its use of resources (e.g. water, paper, stationery, etc.), Northern Rail can reduce the indirect emissions associated with the upstream manufacture and supply, and the downstream processing (e.g. water treatment, waste disposal) of those resources. In addition, conserving resources reduces costs. We therefore recommend that Northern Rail:

- **Measure the use of resources such as water, paper, stationery, etc.**
- **Implement measures to reduce resource consumption, e.g. raising staff awareness, fitting water conservation devices in toilet cisterns, setting printers to print double**

sided as default, moving towards paper-free offices, maximise the efficient use of equipment and desk space etc.

- **Implement measures to reduce the downstream emissions associated with waste processing, such as segregating and recycling waste.**

Conserve resources (physical assets)

In our experience, there is often significant scope for reducing the use of resources associated with an organisation's physical assets, such as electrical equipment, vehicles, etc. The practice of asset management within an organisation usually emerges gradually over time, and is rarely reviewed and tailored to meet the core business objectives. Therefore, it is not uncommon to find that organisations hold more assets than necessary or through focusing on managing operational rather than capital budgets, fail to optimise the lifespan of existing assets. We therefore recommend that Northern Rail:

- **Assess opportunities for improving the efficiency of the use of physical assets by conducting an asset management review.**

Transparency and Openness

We would strongly encourage Northern Rail to publicise these results both encouraging openness and transparency. By commissioning this study, Northern Rail has proofed itself a leader in its sector, a position which would be manifested by publishing this study. Therefore,

- **Make the report publicly available on the Northern Rail website (mirrored by posting on the CenSA and GHD websites)**
- **Submit emissions data to the Carbon Disclosure Project and answer the Supply Chain questionnaire which refers to Scope 3 emissions. Consider participating in CDP's Supply Chain Leadership Collaboration.**

Appendix A: Methodology

Background

Methodologically, the task of calculating carbon footprints can be dealt with by employing one of two approaches using a life-cycle perspective:

- A bottom-up process analysis (PA)
- A top-down environmental input-output (EIO) analysis.

The method of choice will often depend on the purpose of the enquiry and the availability of data and resources. EIO analysis is generally considered superior for the establishment of carbon footprints in holistic systems because it does not rely on the imposition of system boundaries and can utilise readily available data. In this context a carbon footprint of industrial sectors, individual

businesses, larger product groups, households, government, the average citizen or an average member of a particular socio-economic group can easily be performed by input-output analysis. On the other hand, PA has advantages when looking at micro-systems: a particular process, an individual product or a relatively small group of individual products.

Bottomline^3 approach

Every organisation has a complex web of suppliers and clients, each of which contribute their own footprint to the total. In this work, in order to assess the total (cumulative) footprint, we have adopted an extended input-output approach. The method is based on environmental input-output analysis at the national (UK) level, using official data from the ONS National Accounts and Environmental Accounts. This means that all results are fully consistent with standard accounting and fully comparable amongst each other.

The Bottomline^3 UK software employed in this project is based on a static, single-region, open, basic-price, 76-sector industry-by-industry input-output model of the UK economy as of 2000, augmented with a database of environmental, social and economic indicators from 2001. In simplistic terms, the model uses the transactions of the organisation to simulate the effects that this has throughout the wider economy. The model framework is described in Foran et al. 2005a with a summary available in Foran et al. 2005b and a recent example application can be found in Wiedmann et al. 2009. A short summary of the methodology can also be found in Wiedmann and Lenzen 2008.[5]

The comprehensive nature of the input-output approach means that the whole UK economy – including imports and excluding exports – are the system boundary, which is a major advantage to a life-cycle analysis (LCA). Conventional LCAs are based on process analyses, meaning that only on-site, most first-order, and some second-order impacts are considered. The truncation of the system boundary in conventional LCA can lead to a significant underestimation of the true impact. Using Bottomline^3, the error caused by this truncation can be avoided. On the other hand, EIO is limited by the number of sectors it can distinguish (currently 76 in Bottomline^3) and relies on average values for prices and emissions per sector.

Data inputs

Two types of input data are required, financial accounts and on-site fuel use data. Financial accounts include all expenditure and revenue data from one year, ideally as detailed as possible. This includes spending on (purchasing of) equipment, materials, furniture, computers and food but also services like business transport, insurance, banking & financing, legal advice and research. Expenditure categories are mapped to the 76 standard input-output categories used in Bottomline^3.

Data for direct (on-site) energy consumption include fossil fuels needed for heating and vehicles and are in physical units (e.g. kWh of gas).

[5] Further details are available from http://www.isa.org.usyd.edu.au/publications/index.shtml and http://www.isa.org.usyd.edu.au/research/tbltwo.shtml.

Calculation of electricity in Bottomline[3]

There is a constant change in the carbon impact per unit of electricity produced in the UK due to variations in the fuels used in generating electricity to the National Grid. There is therefore some variation in the impact factor used by different tools and models. DEFRA publish a factor as part of their guidance for businesses on Greenhouse Gas reporting[6]. However, this factor is not consistent with the methodology used for calculating Footprint. The methodology used in this analysis ensures that all upstream impacts are accounted for and included within the analysis. Electricity is no different from any other product and therefore all upstream impacts of electricity generation are captured and included. In the DEFRA electricity emissions factor, only the impact corresponding to the fuel required to generate the electricity is considered and therefore this method does not consider the full impacts of electricity generation and indeed there is a considerable carbon impact associated with the interaction of the electricity sector with other sectors. When a full picture of the inputs to the electricity sector is taken into account, the carbon footprint of one unit of electricity is approximately 25% higher than the DEFRA factor. For this study, the conversion factor that accounts for the total carbon footprint has been used (rather than the DEFRA factor) to ensure consistency throughout the report. In addition to the issue of consistency, it is our understanding that Northern Rail wish to obtain an accurate understanding of the Footprint of its operations and not an underestimate of impact. However, this does mean that the factor for electricity is higher than other reports might suggest.

The variation in the DEFRA electricity factor and the factor used in this report has been shown below in Figure 9, along with a projection on the likely impact of electricity.

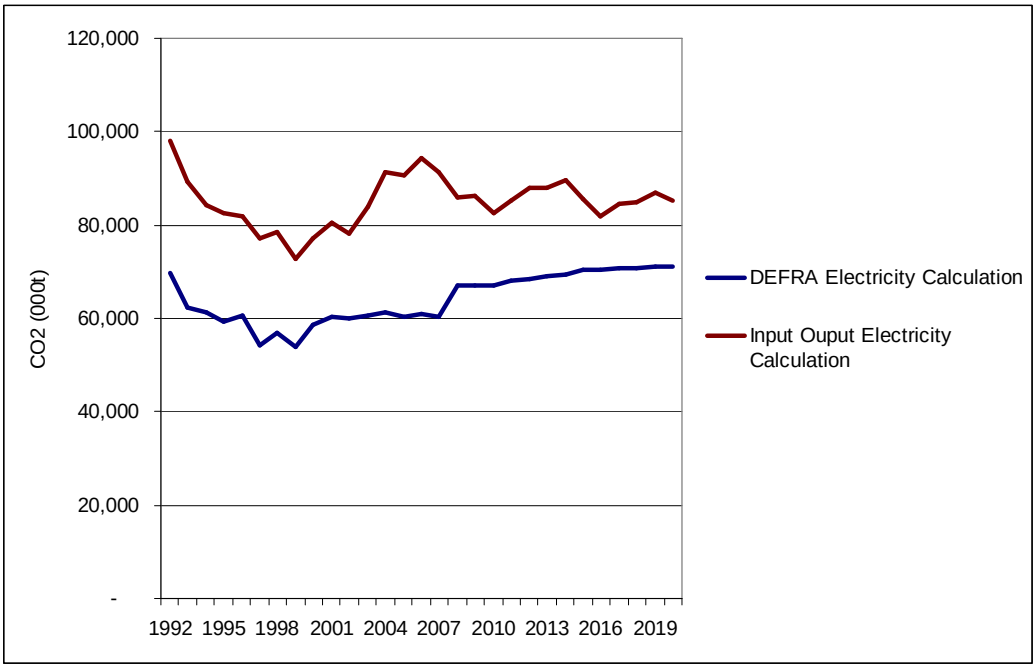

Figure 9: Comparison of emissions from UK electricity production over time

[6] Defra (2005) Company Greenhouse Gas Emissions Reporting Guidelines, available from: http://www.defra.gov.uk/environment/business/envrp/pdf/envrpgas-annexes.pdf [accessed March 2009]

Appendix B: References

British Standards, DEFRA, Carbon Trust (2008) PAS2050:2008 Specification for the assessment of the life cycle greenhouse gas emissions of goods and services

DEFRA (2007) Guidelines to DEFRA's GHG converson factors for company reporting DEFRA (2007) "Guidelines for Company Reporting on Greenhouse Gas Emissions." Retrieved July 2007, from http://www.defra.gov.uk/environment/business/envrp/index.htm.

DEFRA (2009) Draft guidance on how to measure and report your greenhouse gas emissions. 5 June 2009. UK Department for Environment, Food and Rural Affairs, London.

DfT (2007) Delivering a Sustainable Railway. July 2007. Department for Transport, London.

Foran, B., Lenzen, M. and Dey, C. (2005a) Balancing Act: A triple bottom line analysis of the 135 sectors of the Australian economy. CSIRO Technical report. CSIRO Resource Futures and The University of Sydney, Canberra, ACT, Australia. http://www.cse.csiro.au/research/balancingact and http://www.isa.org.usyd.edu.au.

Foran, B., Lenzen, M., Dey, C. and Bilek, M. (2005b) Integrating sustainable chain management with triple bottom line accounting. Ecological Economics 52(2): 143-157. http://dx.doi.org/10.1016/j.ecolecon.2004.06.024.

Lenzen, M., Murray, J., Sack, F. and Wiedmann, T. (2007) Shared producer and consumer responsibility - Theory and practice. Ecological Economics 61(1): 27-42. http://dx.doi.org/10.1016/j.ecolecon.2006.05.018

WBCSD & WRI (2007) The Greenhouse Gas Protocol. A Corporate Accounting and Reporting System.

Wiedmann, T. and Lenzen, M. (2008) Unravelling the Impacts of Supply Chains - A New Triple-Bottom-Line Accounting Approach and Software Tool. In: S. Schaltegger, M. Bennett, R. L. Burritt and C. Jasch, Environmental Management Accounting for Cleaner Production, Chapter 4: 65-90, Springer, Dordrecht, NL > http://dx.doi.org/10.1007/978-1-4020-8913-8_4, http://www.springer.com/978-1-4020-8912-1 .

Wiedmann, T., Lenzen, M. and Barrett, J. (2009) Companies on the Scale - Comparing and Benchmarking the Sustainability Performance of Businesses. Journal of Industrial Ecology. http://dx.doi.org/10.1111/j.1530-9290.2009.00125.x.

WRI and WBCSD (2004) The Greenhouse Gas Protocol - A Corporate Accounting and Reporting Standard. March 2004. World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD). http://www.wbcsd.org/web/publications/ghg-protocol-revised.pdf.