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Business Opportunities and Challenges Presented by Carbon Emissions Targets

Interim Report

A report for the Department of Enterprise, Trade and Investment

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Executive Summary

This report documents the outcomes of Phase 1 of the project, 'Business Opportunities and Challenges Presented by Carbon Emissions Targets', undertaken by a team led by Cambridge Econometrics (CE) and including members from AEA Energy & Environment and SQW Consulting.

The objective of the project is to examine the opportunities and challenges facing Northern Ireland's businesses when meeting national obligations for CO_2 emissions reductions as set out in the UK Climate Change Bill, and to examine the appropriate policy response/framework and instruments that can be adopted to ensure Northern Ireland's businesses contribute to emission reductions.

This project is split into two phases. Phase 1 has focused on;

- a review of existing data sources for energy consumption and CO_2 emissions from the business sector in Northern Ireland (Task 1.2), in order to consider recommendations for how data collection and monitoring might be improved in the future (Task 1.4)
- the establishment of a database of estimates for 2005 that can inform the rest of the project(Task 1.3)

Phase 2 of the project will develop future scenarios for how CO_2 emissions from the business sector may develop between now and 2020 (using CE's Regional Energy Environment Input Output model, REEIO), the ways in which more stringent targets on emissions might be met, the opportunities and challenges that will arise, and the implications for policy.

The definition and scale of business emissions

We define business CO_2 emissions as:

1 the emissions of CO_2 arising from the combustion of fossil fuels in manufacturing sectors, construction and in the service sectors excluding transport (dealt with separately below)

2 the emissions of CO_2 attributable (through the combustion of fossil fuels in power generation) to the use of electricity in the same sectors

3 the emissions of CO_2 attributable (through the combustion of fossil fuels in transport) to the use of transport services by the same sectors, which, in practice, we currently define as road freight transport within NI. The emissions associated with passenger vehicles, rail, air[1] and sea transport are not attributed to businesses, as data limitations make it impossible to estimate transport emissions due to business activities robustly.

With agreement from the Project Board, for the purposes of this project, the business sector does not include:

1 the energy supply industry (to avoid double counting of emissions from electricity sector)

2 agriculture

[1] excluding international aviation

3 public sector activities including defence, education, health and social care provision, and water supplies

To allow comparison of emissions estimates derived in this study with the Northern Ireland Greenhouse Gases Inventory (GHGI), this study will estimate emissions for all non-business sectors as well.

The business sector is responsible for at least 40% of Northern Ireland's CO_2 emissions

On this basis, we estimate that CO_2 emissions from Northern Ireland's businesses amounted to at least 6.62 $mtCO_2$ in 2005, or at least 40% of Northern Ireland's total CO_2 emissions of 16.6 $mtCO_2$[2].

The definition of emissions-responsibility used in this study differs from that used in the NI GHGI, which assigns emissions on the basis of location. For example, if an industrial site demanded 1 MWh of electricity, the GHGI will assign the emissions from the production of this electricity to the power generation sector and not to the industrial sector. Under the GHGI, emissions from transport fuels are assigned to the transport sector.

Task 1.2: Review of existing data sources

The AEA team has reviewed the available energy use and emissions data from the following sources:

1 1990-2005 NI GHGI

2 2005 European Union Emissions Trading Scheme (EU ETS) Emissions Data for NI sites

3 The Carbon Trust's *2002 Northern Ireland Energy Study*

4 Department for Business, Enterprise and Regulatory Reform (BERR) Regional Energy Statistics

5 BERR regional energy consumption statistics for NI Local Authorities, and the annual petroleum and coal inland deliveries data from the Digest of UK Energy Statistics (DUKES)

6 Phoenix and Firmus Gas Data

7 Northern Ireland Electricity (NIE) and Energia supply data, as well as information from the regulator, NIAUR

8 The ongoing Scotland & Northern Ireland Forum for Environmental Research (SNIFFER) GHG Emissions Research project

9 Review of UK aviation GHG emissions

10 Public sector survey of energy use in 2004-05

Our review has analysed the available data to extract the useful elements and assess whether these sources are sufficient to enable development of a robust baseline of Northern Ireland's GHG emissions and to track progress towards emission reduction targets in the business sector, focussing on data for 2005.

Conclusion from the review of data sources

No single data set exists to provide the level of sectoral disaggregation required to satisfactorily measure CO_2 emissions from businesses. Therefore any approach to produce estimates currently requires analysis of a variety of datasets. In addition, there are often discrepancies between estimates of the same item, such as volume of consumption of fuels and energy, from the various sources.

[2] In mtc, these numbers are 1.8 mtc and 4.5mtc respectively.

Data was not readily available in the 44 fuel user groups required by the model

There was insufficient information from fuel suppliers, in particular for the supply of gas and oil products, to identify fuel-use by 44 fuel user groups in the REEIO model. The REEIO model will be used to derive Northern Ireland's 'Business As Usual' energy and emissions projection and scenario-based emission projections in Phase 2 of the project.

In principle, some of the gaps identified in the data could be filled by data gathered directly from participants in the EU ETS and Climate Change Agreements (CCAs). However, in practice confidentiality rules prevented us from using CCA monitoring data because the firms concerned would have been too easily identified.

There is very little direct data on emissions from small sites

Also, the EU ETS data only cover CO_2 emissions at the point of source and so do not identify electricity use by the business sector. Finally, both the EU ETS and CCA data only include emissions from large installations and thus no smaller sites. Table ES1 summarises our assessment of the quality of the data available and used in this study.

TABLE ES1: QUALITATIVE ASSESSMENT OF DATA QUALITY BY SECTOR AND SIZE OF SITE

Sector	Direct on-site emission	Fuel consumption			
		Electricity	Gas	Oil	Coal
Power Generators	EU ETS, IPPC	BERR (Energy Trends)	Via EU ETS these data are available annually		
Manufacturers					
Large	EU ETS, CCA, IPPC	Some site data via NIE, Energia and CCAs. Total from OFREG.	Some large sites included in EU ETS and CCAs, plus info from Phoenix Gas. Other site data from periodic studies.		
Medium	IPPC (some sites)	NIE and Energia. Total from OFREG.	Very limited site data may be obtained from CCA. Uncertain totals from BERR.		
Small	None	BERR and Supplier Data not available in this format			
Services					
Large	EU ETS, CCA, IPPC	Very few site data via NIE, Energia and CCAs.	Some large sites included in EU ETS and CCAs, plus info from Phoenix Gas. Other site data from periodic studies.		
Medium	IPPC (very few sites)	NIE and Energia. Total from OFREG.			
Small	None				

Key

- Good – point source data available annually.
- Okay – limited point source data, some good total fuel use data.
- Poor – insufficient data for robust calculations. No good quality local data.

We recommend that the best way of filling this gap, and to allow robust and regular monitoring of business emissions, is to ask businesses directly to report their fuel consumption for example in the Annual Business Inquiry (ABI) (see section on Task 1.4 for further discussion on this).

Task 1.3: Establish data on CO_2 emissions

The AEA team has researched the available energy and CO_2 emissions statistics from a variety of sources in the development of a more detailed business-sector picture of emissions, including the following:

- As agreed with the Project Board, transport emissions have been analysed by vehicle type and, where possible, we have used data for road freight to form a proxy for transport emissions from business activities.
- Northern Ireland's emissions have been calculated from the point of energy use / generation, with an additional estimate made of emissions from electricity consumption, reflecting the sources that service Northern Ireland's demand (ie we consider emissions from Northern Ireland's three major power plants, plus indigenous renewable sources, and emissions associated with imported and exported electricity).

A 'jig-saw' approach has been taken to construct estimates

This study estimated a snapshot of Northern Irish business emissions, for the 44 sectors required for the REEIO model, which will be used in Phase 2 of the project to project Northern Ireland's future emissions. While this kind of 'jig-saw' approach is sufficient for the purpose of establishing data for the REEIO model to develop emissions projections for Phase 2 of the project, the scale of potential discrepancies is such that it does not provide an adequate basis for monitoring year-on-year changes in fuel use or carbon emissions.

Data from the 2002 Northern Ireland Energy Study has been used extensively to construct estimates for this study

Because it was not possible to identify a detailed sectoral breakdown of fuel use and hence CO_2 emissions from current data sources, we have had to rely on the earlier, one-off *2002 Northern Ireland Energy Study* published by the Carbon Trust to construct a detailed breakdown by sector. Consequently the work has involved gathering (typically partial) information from a range of sources and testing the aggregation of the bottom-up results against separate calculations of the supply of fuels.

Estimates of total energy demand match estimates from suppliers or regulators

As requested by the Project Board

- total gas demand matches the estimate from Phoenix gas
- total electricity demand matches the estimate from the regulator, NIAUR

Sectoral energy demand estimates from the individual suppliers have been used to check sub-totals of energy demand from fuel users.

Key results

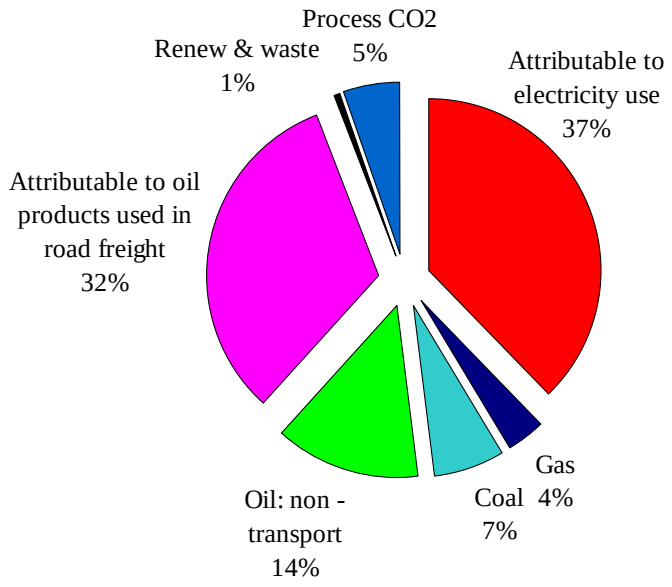
The business sector is responsible for at least 40% of Northern Ireland's CO_2 emissions

By the definition of emissions and of business used in this study, we estimate that CO_2 emissions from Northern Irish businesses amounted to at least 6.62 $mtCO_2$ in 2005, or at least 40% of Northern Ireland's total CO_2 emissions of 16.6 $mtCO_2$[3]. Chart ES1 shows the breakdown of Northern Irish business emissions by source estimated for 2005. Emissions attributable to the consumption of electricity and fuel in road freight transport are responsible for almost 70% of business emissions. In principle, some emissions from other forms of transport (cars, motorbikes, buses, rail, air and sea transport) should also be attributed to business. However, data limitations prevent doing this robustly.

The estimate of total CO_2 from Northern Ireland in this study is 5% higher than the NI Greenhouse Gas Inventory (NI GHGI)

The discrepancy between the two sources lies partly in the differences in the fuel consumption data that underpin the estimates. For example, data for gas and coal consumption used in this study are respectively more than 15% and 30% higher than the estimates used in the NI GHGI. Also, some of the discrepancy is due to use of more NI-specific emissions factors in this study whereas the NI GHG predominantly uses UK-average factors. We believe that the estimate derived in this study is more accurate than the NI GHGI.

CHART ES1: SOURCES OF NORTHERN IRISH BUSINESS CO_2 EMISSIONS, 2005



Source(s) : AEA Energy & Environment data prepared for this project.

[3] In mtc, these numbers are 1.8 mtc and 4.5 mtc respectively.

The sectors with the largest CO_2 emissions are distribution, hotels & restaurants and the larger energy-intensive sectors

Charts ES2 and ES3 present data for CO_2 emissions by key sectors. Chart ES2 orders the sectors by the size of their CO_2 emissions (both direct, through the consumption of fossil fuel, and indirect, through their use of electricity). By this measure, large sectors tend to be nearer the top of the list, even if they are not particularly carbon-intensive. This is the case for distribution, hotels & restaurants and education & health. However, Chart ES3 shows that some energy-intensive sectors are either large enough (in the case of food, drink & tobacco) or energy-intensive enough (in the case of non-metallic mineral products) to feature high in the ranking shown in Chart ES2. In contrast, some energy-intensive sectors (chemicals, basic metals) are relatively small in Northern Ireland, and so they appear lower in the ranking in Chart ES2.

The most energy-intensive sectors, shown in Chart ES3, engage in substantial processing of raw materials for manufacturing. The least energy-intensive are services where the use of energy is almost entirely for space heating and office machinery.

Charts ES4 and ES5 compare the CO_2-intensity of the sectors with economic indicators of interest: productivity and growth in value added over the past decade.

The financial & business services sector has relatively high productivity and low CO_2-intensity

Chart ES4 shows that some high productivity sectors have relatively low CO_2-intensity, notably financial & business services and the considerably smaller wood, paper, printing & publishing sector. Textiles, clothing & leather stands out as a sector with relatively low productivity and high CO_2-intensity. Non metallic mineral products has the highest emissions intensity, though it has middle-ranking productivity

Some of the services are large sectors with relatively low productivity and CO_2-intensity

Notably these are distribution, hotels & restaurants and education & health. Their low productivity is partly because some of the jobs in these sectors are at the low-skill, low-pay end of the spectrum, but partly also because they have a higher share of part-time work (since the productivity measure is value added per *job*) and because of the difficulty of measuring productivity in the public services.

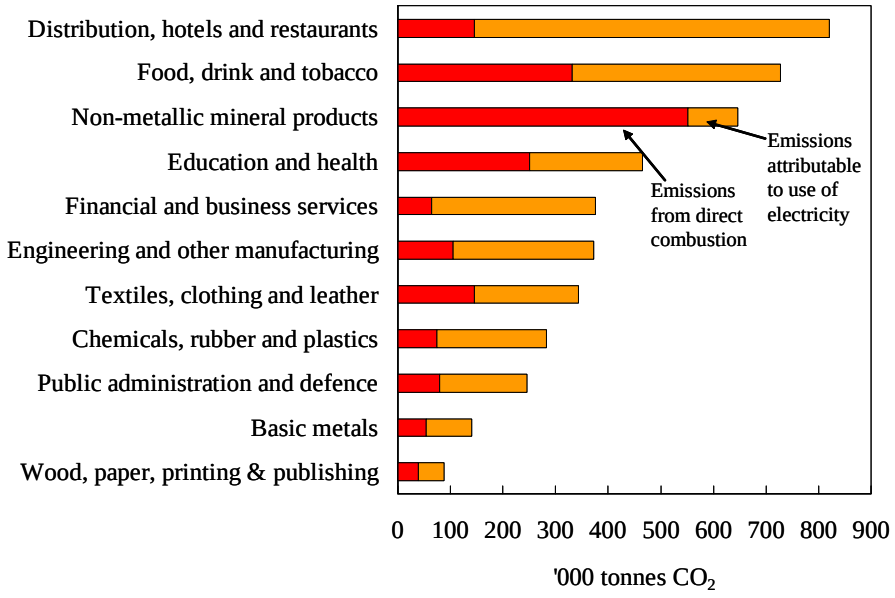
Food & drink is middle-ranking on both CO_2-intensity and productivity

From the point of view of a policy seeking to promote high productivity and low CO_2-intensity, the challenge appears to be greatest in food, drink & tobacco and the much smaller chemicals & plastics sector, since these sectors rank quite highly on both productivity and CO_2-intensity.

Structural change over 1994-2004 has partly favoured low CO_2-intensity sectors

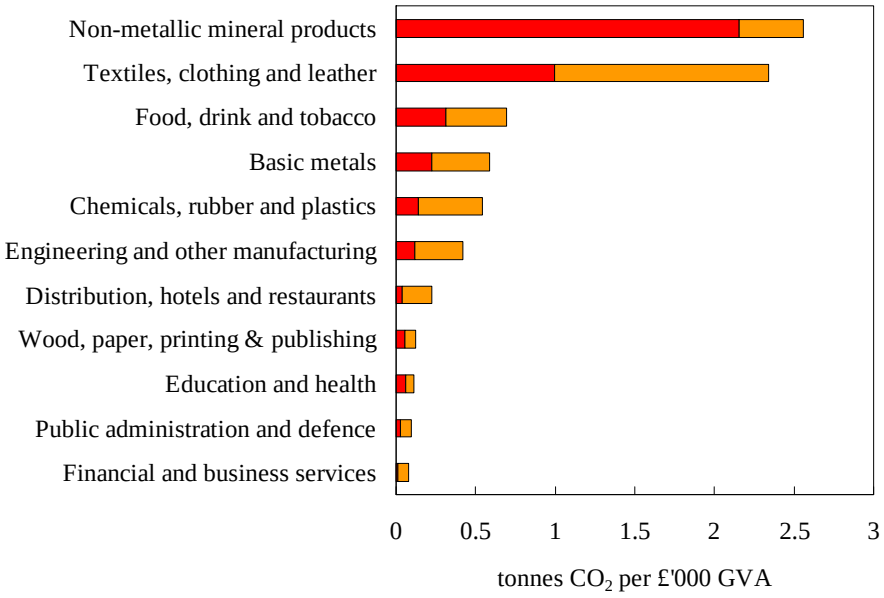
Chart ES5 shows a comparison of the sectors' long-term rates of growth in value added as well as CO_2-intensity. The decline in value added of the (now small) textiles, clothing and leather sector has been helpful in curbing CO_2 emissions as this sector is CO_2-intensive. Similarly, the strong structural shift in favour of financial & business services has supported strong growth in value added with relatively low impact in terms of CO_2. Growth in value added has generally been rather slower, although far from negligible, in the more CO_2-intensive sectors. A notable exception to this is non-metallic mineral products, which has grown reasonably.

CHART ES2: PRINCIPAL SOURCES OF CO_2 EMISSIONS IN NORTHERN IRELAND, 2005



Source(s) : AEA Energy & Environment data prepared for this project.

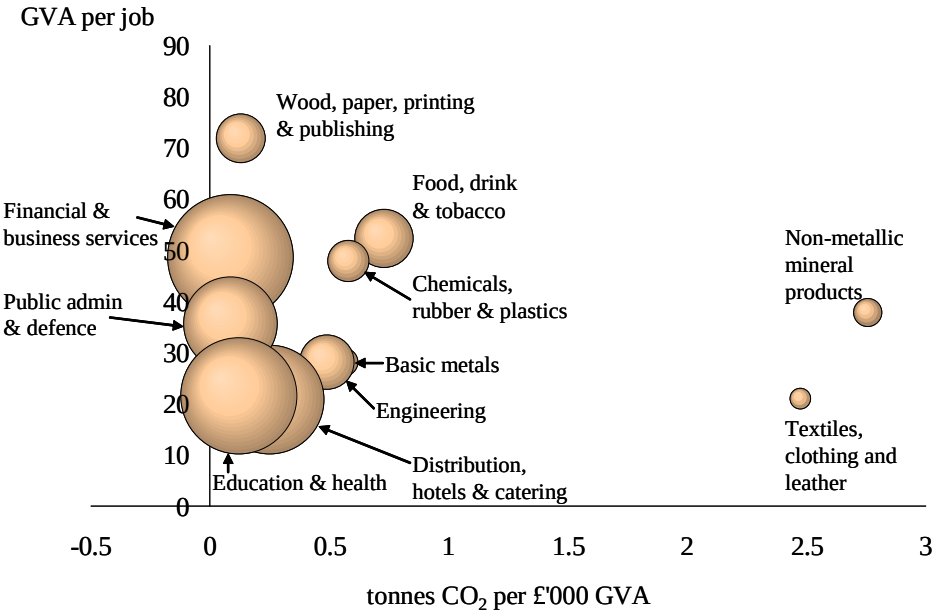
CHART ES3: CO_2-INTENSITY OF PRODUCTION AMONG SECTORS IN NORTHERN IRELAND, 2005[1]



Note(s) : GVA data used in the denominator are 'headline' data for 2004, as data for 2005 was not released when data this chart was first compiled

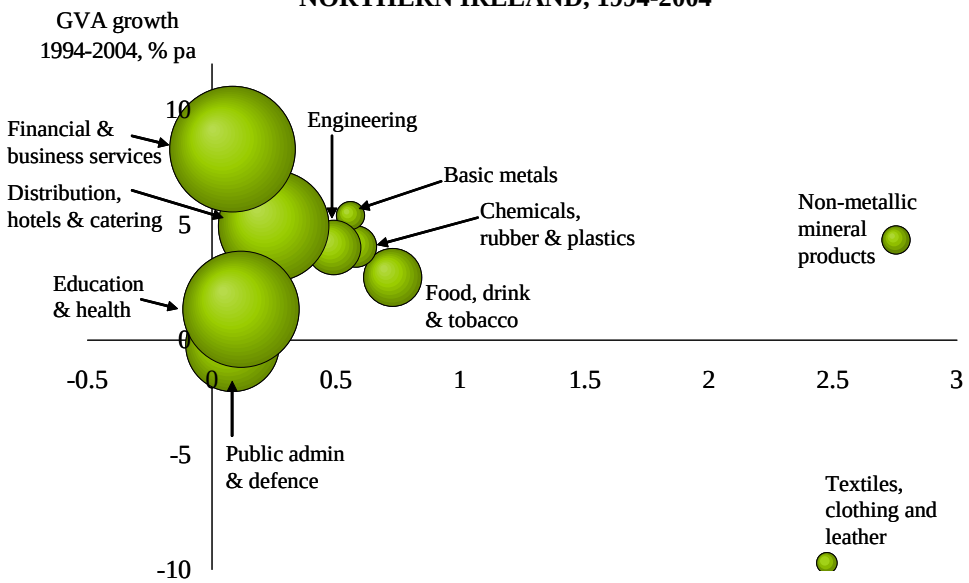
Source(s) : AEA Energy & Environment data prepared for this project; ONS Regional Accounts.

CHART ES4: CO_2-INTENSITY AND PRODUCTIVITY AMONG SECTORS IN NORTHERN IRELAND, 2005[1]



Note(s) : 1 GVA data used in the denominator are 'headline' data for 2004, as data for 2005 have not yet been released. Jobs data are for 2004 and include an estimate for self-employment.
2 The size of the bubbles is proportional to the GVA of the sector in 2004.
Source(s) : AEA Energy & Environment data prepared for this project; ONS Regional Accounts.

CHART ES5: CO_2-INTENSITY AND GVA GROWTH AMONG SECTORS IN NORTHERN IRELAND, 1994-2004[1]



Note(s) : 1 GVA growth over 1994-2004 is estimated chained volume measure, using UK data for sectoral deflators. CO_2 intensity is 2005 CO_2 emissions divided by 2004 GVA headline measure.
2 The size of the bubbles is proportional to the GVA of the sector in 2004.
Source(s) : AEA Energy & Environment data prepared for this project; ONS Regional Accounts.

Benchmarking with other parts of the UK and other EU member states

The quality of data available to conduct a benchmarking exercise against other parts of the UK is not high. The work undertaken for this study has developed a database for Northern Ireland, but comparable work has not been undertaken for the other UK countries and for the regions of England. We compare the data prepared for Northern Ireland against data that were prepared in an earlier project for the nations of the UK and regions of England which was based on an analysis of the data collected for the National Air Emissions Inventory together with supplementary analysis using UK sources. Because of the potential differences in methodology, the results are indicative rather than definitive. They show that some sectors of Northern Ireland appear to be in the upper end of the ranking of regions in terms of carbon-intensity, but others are not. One factor influencing this result lies in differences in productivity: where value added per worker is lower in Northern Ireland, it is likely that carbon emissions per unit of value added will be higher.

This study also compared fuel consumption in Northern Ireland with that of other parts of the UK, Germany, Denmark and the Republic of Ireland (RoI). Oil plays a more prominent part in Northern Irish businesses fuel use than in other parts of the UK, where it is more concentrated in road transport use. Industry and services share of energy consumption in Northern Ireland is lower (26%) compared to Germany, Denmark and the RoI (34-41%).

Task 1.4: Recommendations to further improve data collection

The AEA team has considered the analysis of existing resources and has compiled a number of recommendations for the consideration of the Project Board, aimed at the further enhancement of data collection mechanisms to address information gaps, which will allow for an improved understanding, and facilitate regular monitoring, of GHG emissions from Northern Ireland's businesses. The main issues identified are discussed briefly below.

There is a lack of data on direct emissions from businesses not covered in the EU ETS

Regular, systematic, direct reporting on emissions occurs only for installations regulated under the EU ETS. Apart from power generation, which has large plants comprehensively covered by the EU ETS, the coverage is limited to a relatively small number of highly fossil-fuel-intensive processes. Since future UK policy developments are shifting their focus to installations and firms not in the EU ETS, this group is also likely to be the focus of any NI-specific policies. The lack of data on these energy users is a particular weakness with regard to analysis and future monitoring.

Information available from energy suppliers is only useful for broad aggregates

Energy suppliers, in particular the gas supplier, have very limited information about the breakdown of their customers beyond 'residential' and 'industrial & commercial' (and even those estimates may just be based on the scale of consumption). While electricity suppliers have a more detailed breakdown, this was still not sufficient for the breakdown required for the REEIO model. Also there is a discrepancy between the implied total using supplier data and the total estimated by the regulator NIAUR.

There is typically no Standard Industrial Classification (SIC) coding to allow for the identification of the industrial sector of a particular fuel user. Where the supply is not through fixed networks (as for electricity and natural gas), estimates of the supply itself can be uncertain (this is particularly the case for petroleum products and road transport fuels).

To improve estimates of fuel use by business, and hence CO2 emissions, we recommend an extension of the questions in the Annual Business Inquiry to cover energy consumption by fuel type

Although a broad picture of energy use and CO_2 emissions can be built up by the 'jigsaw' approach adopted here, the scale of the potential errors in this exercise are such that it does not represent an adequate method for measuring year-on-year changes in CO_2 emissions by business. Nor does it allow for adequate monitoring of energy use by detailed sector, which is an important indicator for assessing the effectiveness of policies targeted at particular sectors.

The counter-argument to this recommendation is that it may impose an additional reporting burden on business. Our response to this is two-fold. Firstly, it would not impose any additional burden for large installations that already have to report under the EU ETS or CCAs. Secondly, if we are to be successful in curbing CO_2 emissions it is clearly essential for businesses to be aware of what their energy use is. In this case, a requirement to report energy consumption supports the goal of promoting awareness of energy consumption, which is the first step towards encouraging greater energy efficiency. We already require businesses to report statistics for turnover, value added and employment and the imperative to curb CO_2 emissions seems sufficiently important to warrant the imposition of this likely modest additional reporting burden.

If such direct reporting of energy consumption were introduced, a proper analysis of energy consumption would still require an exercise to construct an energy balance to cross-check the survey results. However, the derivation of estimates from such a process would be much easier to compile and more robust if survey data were available.

Conducting regular studies akin to the 2002 Northern Ireland Energy Study

If extension of the ABI were rejected as a policy option, then we suggest that, as a second-best solution, a study of the same kind as the Carbon Trust's *2002 Northern Ireland Energy Study* be undertaken on a regular basis. The 2002 study provided the best source of comprehensive data on fuel use by industry sector for this project. However, the scale of the task of corroborating the various data sources would probably rule out the prospect of undertaking such a study on an annual basis.

1 Introduction

The objective of the project is to examine not only the opportunities and challenges facing Northern Ireland's businesses when meeting national obligations for CO_2 emissions reductions as set out in the UK Climate Change Bill but also to examine the appropriate Northern Ireland policy response/framework and instruments that can be adopted to ensure Northern Ireland's businesses contribute to emission reductions.

This report documents the outcomes of Phase 1 of the project, 'Business Opportunities and Challenges Presented by Carbon Emissions Targets', being undertaken by a team led by Cambridge Econometrics and including members from AEA Energy & Environment and SQW Consulting.

Phase 1 has focused on a review of existing data sources for energy consumption and CO_2 emissions from the business sector in Northern Ireland, the establishment of a database of estimates for 2005 that can inform the rest of the project, and consideration of recommendations for how data collection and monitoring might be improved in the future.

The principal authors of this report are Glen Thistlethwaite, Paul Stevenson and Martyn Hann of AEA Energy & Environment, and Richard Lewney and Jamal Tarafdar of Cambridge Econometrics.

What are business emissions?

For the purposes of this project, we define *business* CO_2 emissions as:

1 the emissions of CO_2 arising from the combustion of fossil fuels in manufacturing sectors, construction and in the service sectors excluding transport (dealt with separately below)

2 the emissions of CO_2 attributable (through the combustion of fossil fuels in power generation) to the use of electricity in the same sectors

3 the emissions of CO_2 attributable (through the combustion of fossil fuels in transport) to the use of transport services by the same sectors, which, in practice, we currently define as road freight transport within Northern Ireland. The emissions associated with passenger vehicles, rail, air and sea transport are not attributed to businesses as data limitations make it impossible to distinguish the emissions attributable to freight and passengers in air and sea.

For the purposes of this project, the business sector does not include:

1 the energy supply industry (to avoid double counting of emissions from electricity sector)

2 agriculture

3 public sector activities including defence, education, and health and social care provision, and water supply

The definition for responsibility of emissions used in this study does not match the one used in Northern Ireland Greenhouse Gases Inventory (GHGI) which assigns emissions on the basis of location. For example, if an industrial site demanded 1MWh of electricity, the GHGI will assign the emissions from the production of this electricity to the power generation sector and not to the industrial sector. Under the GHGI all transport fuels are assigned to the sector transport.

Currently, emissions for Northern Ireland are calculated on an annual basis in Northern Ireland GHGI, which is derived from the UK GHGI used to monitor the UK's performance against Kyoto emissions-reduction targets. The GHGI will also be used to monitor the UK's progress towards domestic emissions-reduction targets set out in the Climate Change Bill.

Taking account of emissions from demanded energy can lead to large changes in the amount of emissions attributed to fuel users. For example, according to the UK GHGI, 15.6%[4] of direct emissions in the UK in 2004 came from households, but factoring in emissions from electricity and transport fuel consumption[5], energy demand from households is estimated to be responsible for 42% of UK CO_2 emissions[6].

Acknowledgements

We wish to acknowledge the help of the following staff and organisations in this phase of the project:

- Stephen Moore (DETI), Anne Tohill (DETI), Bobby Clulow (OFMDFM) and Stuart McAllister (OFMDFM)
- Phelim Sands at the Northern Ireland Department of Environment (DoE)
- Nicola Quinn at Phoenix Gas
- Gerry Forde at Northern Ireland Electricity
- Desmond George at Energia
- Anke Herold and Riitta Pipatti of the EEA Working Group 1 on GHG Emissions Inventory development
- Peter Taylor of the International Energy Agency (EU-wide EU ETS analysis & expertise)
- Andrew Lelland, Project Manager for the compilation of the Environmental Accounts for the UK Office of National Statistics (ONS) (excludes electricity energy use data and emissions)
- contacts in Germany, the Netherlands, Denmark, Norway, Finland, France and Ireland on the ODYSSEE7 energy efficiency indicators project

Contents

The report is structured according to the tasks established for Phase 1 of the project:

- Chapter 2 presents the review of existing data sources (Task 1.2)
- Chapter 3 presents the methodology for the establishment of data on CO_2 emissions (Task 1.3)
- Chapter 4 summarises and interprets the key results (from Task 1.3)
- Chapter 5 presents recommendations to improve data collection in future (Task 1.4)

[4] DEFRA Statistical Press Release, '2005 UK climate change sustainable development indicator and greenhouse gas emissions final figures', see http://www.defra.gov.uk/news/2007/070131a.htm.

[5] Includes emissions from international aviation, which is not included in GHG inventory

[6] 'UK Energy Efficiency Action Plan', see http://ec.europa.eu/energy/demand/legislation/doc/neeap/uk_en.pdf.

[7] See www.odyssee-indicators.org.

2 Review of Existing Data Sources

The AEA team has reviewed the available energy use and emissions data in order establish the baseline emissions for the REEIO model which will be used to project 'Business As Usual' and scenario emissions in Phase 2 of the project. Also, this review forms the basis of recommendations for how data collection can be improved to allow regular and robust monitoring of emissions from the business sector in the future (see Chapter 5 for further details).

2.1 Key Findings

The following sources were considered:

1 1990-2005 Northern Ireland GHGI

2 2005 EU ETS Emissions Data for Northern Ireland sites

3 The Carbon Trust's *2002 Northern Ireland Energy Study*

4 BERR Regional Energy Statistics

5 BERR regional energy consumption statistics for Northern Ireland Local Authorities, and the annual petroleum and coal inland deliveries data from DUKES

6 Phoenix and Firmus Gas Data

7 NIE, Energia and NIAUR electricity supply data

8 the ongoing SNIFFER GHG Emissions Research project

9 Review of UK aviation GHG emissions

10 Public sector survey of energy use in 2004-05

Information from Climate Change Agreements was not considered

Large, energy-intensive industrial firms, subject to international competition, are given an 80% discount on the Climate Change Levy (CCL) in return for agreeing to make cuts in their emissions. Such agreements are called 'Climate Change Agreements' (CCAs), and the data submitted to enable monitoring and verification of the emission cuts could provide very robust data on fuel-use by participants.

However, we were not able to use this data for this project as the small number of participants operating in Northern Ireland would have breached confidentiality rules which govern the disseminating of this data. In any case, this data would only report the large installations which are captured by this policy and would not provide any information on smaller sites not in the scheme.

No single data set exists to provide the level of sectoral disaggregation required to identify the opportunities and challenges to business of carbon reduction targets

A summary of the key findings from each data-source investigated is listed below. A particular issue was the unavailability of data explicitly for the 44 fuel user groups required by the REEIO model. While data was usually available at broader sectoral disaggregation, data was not readily available at the 44 fuel user group level required by REEIO. Chapter 3 discusses how estimates for the fuel user groups were derived. Therefore any approach would require using a variety of datasets.

There was also insufficient information to allow robust linking of fuel supply data, in particular gas, to sectoral activity of fuel users. While there is data available to aid this, such as the EU –ETS and information provided by participants in CCAs, there was limited scope to use this data because of confidentiality concerns. In the case of CCA data it would have been possible to identify the firms concerned.

2.2 Degree of confidence in data sources

We have various degrees of confidence in the various data sources. Table 2.1 below uses a 'traffic light' system to illustrate our assessment of the confidence in the various elements of the estimates, with a qualitative assessment / expert judgement covering the accuracy of the data and the frequency with which the data are typically updated. See also Appendix E for a qualitative assessment of sector-specific data uncertainty.

Green indicates sources where good quality point source data are available on an annual basis. Yellow indicates where there are some good quality fuel use or emissions data supplemented (to provide sub-sectoral detail) by proxy data or more uncertain historical data. Red indicates sources where even the top-level fuel use or activity data are quite uncertain and local data are not available to provide sector detail.

In summary:

- good quality data are available for the power generation and energy sectors, energy-intensive industrial sites, air, rail and road transport sources and for the public sector
- average quality data are available for most industrial and commercial sub-sectors, as well as for domestic sector oil, gas and electricity use
- poor quality data are evident for the marine shipping sector, domestic solid fuel use and the agriculture sector

We recommend that the best way of filling this gap to allow robust and regular monitoring of business emissions in the future is to ask businesses directly to report their fuel consumption for example in the ABI (see Chapter 5 for further discussion).

TABLE 2.1: QUALITATIVE ASSESSMENT OF DATA QUALITY BY SECTOR AND SIZE OF SITE

Sector	Direct on-site emission	Fuel consumption			
		Electricity	Gas	Oil	Coal
Power Generators	EU ETS, IPPC	BERR (Energy Trends)	Via EU ETS these data are available annually		
Manufacturers					
Large	EU ETS, CCA, IPPC	Some site data via NIE, Energia and CCAs. Total from OFREG.	Some large sites included in EU ETS and CCAs, plus info from Phoenix Gas. Other site data from periodic studies.		
Medium	IPPC (some sites)	NIE and Energia. Total from OFREG.	Very limited site data may be obtained from CCA. Uncertain totals from BERR.		
Small	None	BERR and Supplier Data not available in this format			
Services					
Large	EU ETS, CCA, IPPC	Very few site data via NIE, Energia and CCAs.	Some large sites included in EU ETS and CCAs, plus info from Phoenix Gas. Other site data from periodic studies.		
Medium	IPPC (very few sites)	NIE and Energia. Total from OFREG.			
Small	None				

Key

- Good – point source data available annually.
- Okay – limited point source data, some good total fuel use data.
- Poor – insufficient data for robust calculations. No good quality local data.

2.3 Summary of data Sources

1990-2005 Northern Ireland Greenhouse Gas Inventory (NI GHGI)

The UK GHGI is compiled by applying emissions factors on appropriate activity indicators. It is compiled on an annual basis, each year the latest set of data are added to the inventory and the full time series (1970-2005) is updated to take account of improved data and any advances in the methodology used to estimate the emissions.

Activity statistics are obtained from Government statistical sources, such as the Digest of UK Energy Statistics, Transport Statistics Great Britain, and from other organisations such as trade associations and research institutes - for example the UK Petroleum Industries Association (UKPIA) provide data on the sulphur content of fuels, and the Institute of Grassland and Environmental Research (IGER) provide data on livestock numbers and fertilizer usage.

The NI GHGI assign emissions by location of direct emitter

The NI GHGI is derived by appropriate apportioning of the UK GHGI. It assigns emissions by location, for example all emissions from electricity are attributed to power generation rather than the sector responsible for demand. The overall geographical distribution of emissions across the UK is built up from the pattern of component distributions for each emitting sector.

These individual sectoral distributions are developed using a set of statistics appropriate to that sector. For large industrial 'point' sources, emissions are compiled from a variety of official UK sources (Environment Agency, Scottish Environmental Protection Agency, Local Authority data). For sources that are distributed widely across the UK (known as 'area' sources), a distribution map is generated using appropriate surrogate statistics for that sector.

The NI GHGI has strengths and weaknesses

The NI GHGI has good quality data on emissions from the power sector. However, data on combustion and process-emissions from firms in the 'other industrial' and commercial sectors are considered to be poor due to general uncertainty of fuel use and activity levels in Northern Ireland. Emission profiles can vary significantly from year-to-year as the full historical time series can be revised in light of methodological improvements. Regional emissions data for 2005 was made available in August 2007.

Appendix B gives an appraisal of the levels of data uncertainty in the NI GHGI. More information about the methodology used to compile the inventory is available from National Atmospheric Emissions Inventory website[8], including the methods used to compile the emission inventories for each of the devolved authorities and England[9].

2005 EU ETS emissions data for Northern Ireland sites

22 sites in Northern Ireland reported their emissions to the EU ETS for 2005. These sites also reported their energy consumption. The usefulness of the EU ETS data was found to be limited for some sectors where, for example, only one out of the two cement kiln operators in Northern Ireland had submitted data to the EU ETS (due to the second site being regulated under a pre-existing CCA).

The EU-ETS fuel use and CO_2 emissions data are calculated by site operators of energy intensive sites that trade in the scheme. These data are collated annually by the NI DoE to enable regulation of the annual CO_2 emissions, through comparison of actual emissions against a site's annual allowance. The CO_2 emissions data are verified by independent auditors, and the data are released to the public domain, typically by the end of May in 'Year +1' (eg emissions data for 2008 will become available by the end of May 2009).

However, the site-specific fuel use data are not verified and are not released to the public domain. These have been obtained directly from contacts in Northern Ireland's DoE and are treated as commercial in confidence.

EU ETS emissions data are very volatile

The variability of EU ETS emissions data from the major fuel consuming sites in Northern Ireland has a significant impact on any given year's estimate of CO_2 emissions in Northern Ireland and suggests that it could be difficult to assess broader trends until a run of some years were recorded.

For example, in 2005, the sum of the NI EU ETS emissions was less than the sum of the site allocations by 649.2 $ktCO_2$, 10.5% below the total allocated emissions for that

[8] See http://www.naei.org.uk/

[9] AEA (2007) *Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990 - 2005*, available at http://www.airquality.co.uk/archive/reports/cat07/0709180907_DA_GHGI_report_2005.pdf.

year. In 2006, however, the sum of the NI EU ETS emissions was 31.9 $ktCO_2$ above the sum of the site allocations, 0.5% above the total allocated emissions for that year.

2002 Northern Ireland Energy Study

The 2002 Northern Ireland Energy Study[10] has formed the basis of our analysis for industrial sectors. This work estimated the energy demands and emissions of several hundred industrial and commercial sites across Northern Ireland for 2002, as well as projecting the demand in 2012. The study involved collaborating a range of sources including aggregate statistics, data from energy suppliers and analysis of energy demand of individual sites. This approach was mimicked in this study. This was a one-off study and which took almost a year to complete.

BERR regional energy statistics

These statistics are only useful to check fuel consumption estimates at broad sectoral desegregations

The 2005 BERR regional energy statistics were only published in the December 2007 edition of *Energy Trend*. However, as we have contact within the team of energy statisticians that produce these data, the AEA project team was able to include a revision of the draft version of these data in time for inclusion within Phase 1 of this study.

These data have useful as a further verification of the derived fuel use estimates. However, as the BERR regional energy statistics only provide estimates for broad end-user groups ('industrial sources', 'commercial & institutional sources', 'public sector') and are aggregated for some fuel groups (eg 'oils'), see Table 2.2. Therefore data from this source have predominantly been used to check the sum of different fuel user group estimates.

BERR regional energy consumption statistics for NI local authorities, and the annual petroleum and coal inland deliveries data from DUKES

The regional energy use statistics are experimental data, whilst the annual coal and petroleum inland deliveries data do not provide any detail regarding end-use of the various fuels. In addition, the solid and liquid fuel use data are subject to uncertainty due to unknown levels of stockpiling from year to year.

Energy supplier data

Phoenix gas supply data have limited sector-specific information and was used to verify gas consumption estimates

The main gas supplier in Northern Ireland has provided data by end-user, divided by scale of gas use. They also provided an estimated sectoral split of gas users, see Table 2.3. However, only limited sector-specific estimates have been provided and some of these are questionable when compared against the findings from previous studies (notably the allocation to agriculture, which has been re-distributed across agriculture and the food & drink industry in this analysis). Therefore, once again, these data are only of limited usefulness but have been used to inform some parts of the sectoral split and to verify the overall gas consumption figures.

[10] Carbon Trust (2005) *Northern Ireland Energy Study 2002*, available at www.carbontrust.co.uk/Publications/publicationdetail.htm?productid=CT-2003-10.

Phoenix Gas collected the data from a manual trawl of their billing records as this is something that their systems appear not to be set up to provide. The trawl involved allocating their largest customers to industry classifications, which was provided by AEA.

NIE and Energia electricity supply data covered 71% of electricity consumed in Northern Ireland

NIE and Energia provided data which covered 71% of electricity supplied to NI consumers. Additional data from four smaller electricity providers have not been acquired. While these data sources provide a quite detailed assessment of industrial & commercial electricity use (see Table 2.4 for sectoral disaggregation of NIE data), this was broader than the 44 fuel user groups in the REEIO model. This has therefore been used in conjunction with historical data on sector-specific electricity use (from the 2002 NI Energy Study) to inform the fuel user group estimates for 2005.

Consequent discussions with NIE have revealed that they could have provided more detailed data which would have mainly lead to a greater sectoral disaggregation of electricity supplied to the Commercial sector. Since we asked for the most detailed data they could provide, we were unaware that they had opted to give us data they had aggregated. However, the added value of conducting the exercise with the more detailed data is diminished without consideration of data from the electricity suppliers that also sell to the Northern Irish market place. There were not enough resources in the project to incorporate the new data from NIE and gathering data from the other suppliers.

Total supply data from the regulator (NIAUR)

The estimate of the total electricity supply data was provided by the regulator, NIAUR. This estimate (for the total) was lower (around 8.2 GWh) than that implied by scaling up the estimates provided by NIE and Energia (around 8.6 GWh).

The following data were not evaluated

SNIFFER GHG Emissions Research project - no data from this project had been used in the estimates derived in this project as it had only been initiated at the time of estimation. While the project is unlikely to develop improved data for 2005 (for use in the present study), it might provide some sector-specific projections that could be used to inform the Phase 2 scenario modelling. However, no such data have been identified yet.

Review of UK aviation GHG emissions - Ongoing work to review the scope of aircraft flight information used in the NI GHGI is also unlikely to become available in time for this study. Hence the estimates for aviation emissions may be revised slightly in the coming months. We have consulted with the team that compiles UK aviation GHG emissions (a team of air transport experts within AEA in conjunction with contacts at the Civil Aviation Authority) and these revisions are not expected to be significant

TRL review of road transport emissions factors - To date, the TRL revision of road transport emission factors has not been completed, and hence this source has not been available for the project team to review.

Non business data

While this study focuses on the business sector, the AEA team also derived energy consumption and emission estimates for other sectors of the economy including the households and the public sector.

Public sector survey of energy use in 2004-05

A report from a public sector survey of energy use in 2004-05 was provided by the Department of Finance & Personnel Northern Ireland (DFPNI) and this has been used to revise the detailed breakdown of energy use patterns across institutions and Government Departments in Northern Ireland, including the water supply services. We have not analysed this dataset to any significant extent as the public sector is not the focus of this study.

TABLE 2.2: FUEL USE DISAGGREGATION IN 2005 BERR REGIONAL ENERGY STATISTICS

Industry	Domestic	Rail	Public	Commercial	Agriculture	Other
Fuel Oil, Gas Oil, LPG, OPG, Petrol, Burning oil (kerosene), lubricants, coal, coke, petcoke, flare gas	coal, oil, solid smokeless fuel	Oil	coal, oil	coal, oil	coal, oil	waste solvents, clinical waste, scrap tyres, wood

TABLE 2.3: PHOENIX ESTIMATES OF SECTORAL SPLIT OF INDUSTRIAL AND COMMERCIAL GAS USERS

Sector	Fuel use share (%)
Agriculture	8
Basic metals	8
Minerals	1
Chemicals	1
Other industry	12
Commerce / public / business	70

TABLE 2.4: SECTORAL DISAGGREGATION OF NIE ELECTRICITY SALES DATA

Industrial Sub Sectors	Commercial Sub Sectors	Energy Industries Sub Sectors	Other Main Sectors
Iron and steel	Wholesale and retail distribution	Extraction of oil and gas	Transport and storage
Food, beverages and tobacco	Insurance, banks, offices	Coal and coke	Agriculture
Mineral products	Hotels and restaurants	Petroleum refineries	Public lighting
Mechanical engineering and metal products	Combined domestic and commercial premises	Nuclear fuel production	Public administration
Electrical and instrument engineering	Post and telecommunications	Gas and electricity supply	Domestic
Chemicals			Construction
Vehicles			Other services
Non-ferrous metals			Unclassified
Textiles, clothes, leather and leather products			
Pulp, paper, publishing and printing			
Other industries			

3 Establishment of Data on Energy Use and CO_2 Emissions

3.1 Objective and overview of method

The objective of this task was to develop a 2005 base year estimate of energy use and CO_2 emissions by the 44 fuel user (FU) categories and the fuels required for the REEIO model, which will be used to project future Northern Irish emissions in Phase 2 of the project.

Estimation of the emissions for each business sector requires the following:

- estimation of direct emissions from business sites ie from combustion of fuels on site or emissions from industrial processes. This requires estimating the fuel consumption of combustibles such as gas, oil and solid fuel.
- estimation of indirect emissions attributable to electricity consumption. This involves estimating electricity consumption for each sector and then applying an emission factor to estimate emissions from electricity consumption
- estimation of emissions from road transport freight (as a proxy for business-related transport emissions). However, it is not possible to assign freight emissions to any particular sub-sector, and data limitations prevent us from distinguishing business-use of road passenger vehicles, rail, air and sea transport and in turn the apportionment of these emissions to the business sector

A 'jig-saw' approach has been taken to construct estimates

The estimates were developed by taking energy use data from several sources, using expert judgement to assess the validity of the various options. The AEA team has re-evaluated the total energy and fuel split, particularly for the Industry and Commercial sectors, seeking to ensure that the sum of the fuel user 'bottom-up' energy data balances reasonably well with the top-down energy-supply data.

Section 3.2 discusses the sector classifications of the REEIO model. Section 3.3 discusses the derivation of the emission factors used. Section 3.4 discusses the methodology used to derive emissions estimates for each of the subsectors in the REEIO classification. See Chapter 2 for further details on the data sources used.

3.2 REEIO Sector Classifications

The first step in the analysis was to clarify the 44 fuel user groups, as required for the subsequent modelling work by CE. Allocation of different industries (by SIC code) across these 44 groups was agreed with CE. Known sites in Northern Ireland were assigned to the most appropriate FU group throughout the analysis of the various energy and emissions datasets.

The fuel user classification adopted for the categorisation of data (based on that used in REEIO, which in turn represents an extension of the categories used in the Energy Balance tables in DUKES) is shown in the tables in Appendix C.

The tables in Appendix C show the relevant SIC codes for the fuel users that are defined as industries. The following fuel users are not defined as part of the business sector for this study (see Table C2):

- the energy supply industry (which are defined according to the purpose of their fuel use, ie for own use or transformation)

- transport fuel users (which are defined by mode of transport used, rather than the industry sectors which provide transport services)
- domestic (residential) fuel users (not an industry sector)
- sectors providing public services

3.3 Derivation of energy to CO_2 emission factors

Emissions of CO_2 are not, in general, measured directly. Rather, they are inferred from estimates of consumption of the relevant fossil fuel. The estimated kg CO_2 per kWh of energy consumption is the 'emissions factor'. Table 3.1 presents the estimated emissions factors used in this study.

Emissions factor for direct fossil fuel use

For direct use of fossil fuels (primarily gas and non–transport use of oil and coal), we have adopted emissions factors used for monitoring of sites in EU ETS, grouping together all oil types (as there is typically insufficient detail in oil-use data and the differences between factors for commonly-used oils are small).

Electricity emissions factor

For the purposes of this study, CO_2 emissions associated with electricity generation are also to be estimated and attributed to the point of consumption. We have therefore calculated a CO_2/kWh factor for electricity consumed by end-users based on the following sources and assumptions:

- the emissions factor is based predominantly on Northern Ireland's three power stations (plus the small amount of renewables generation) and associated CO_2 emissions, as recorded in the NI GHGI.
- the factor takes into account self-consumption and transmission / distribution losses; typically, 10-15% of electricity generated is lost, ie for every 100 kWh generated only 85-90 kWh reaches the consumer
- the factor accounts for electricity imports/ exports. For 2005, these are fairly small. However, they are likely to grow over time given the recent operation of the single 'All Ireland' electricity market.

TABLE 3.1: CO_2 EMISSION FACTORS

Fuel	kg CO_2 / kWh
Electricity (for attribution to final energy use)	0.634
Gas	0.186
Coal	0.322
Oils	0.262
Renewables & waste	0

3.4 Methodology for estimating energy use and emissions for specific fuel user categories

The following documentation notes the treatment adopted for specific fuel users (see tables in Appendix C for the definition of these categories).

Business Sector estimates

FU 5 to 23: Industrial Sector

Estimates have been constructed based on the 2002 Northern Ireland Energy Study and 2005 EU ETS data, with totals assessed against the appropriate IPCC sector estimates in the 2005 Northern Ireland GHG inventory and reported energy use data from suppliers such as Phoenix gas. The detail of the 2002 study provides a good indication of the number and size of industrial operations in each FU group, and a good indication of the spread of fuel types used within each FU sector.

The AEA team conducted resource-limited research via available web-based documents and consulted with individuals in The Carbon Trust in Northern Ireland (CTNI), in particular to identify larger sites that may have converted over to using gas in the intervening years if their location is near to the extended gas supply network.

Data from EU ETS monitoring effectively provided a 'de-minimis' energy use for some fuels and sectors. Direct consultation with CTNI, together with the fuel supplier data, has enabled us to derive improved 2005-specific estimates.

In addition, cross-checks have been conducted to compare the derived sub and grand totals against:

- Phoenix Gas, Northern Ireland Electricity, Energia (used to check sub totals), OFREG and inland deliveries data for oil & coal supply (used to check grand totals)
- Northern Ireland GHGI data for direct fossil fuel combustion emissions

Through these efforts the fuel use patterns across industrial (and commercial) sub-sectors have been analysed. Our findings are subject to uncertainty as it has not been feasible to revisit data for all of the sites contacted within the original study, but the general fuel-switching trends from oil and solid fuels towards gas have been captured because we have constrained the data to the overall energy-use datasets.

This method was also used for the fuel user 22: water supply, though this is not classed as a 'business'.

FU 32 to 41: Commercial Sector

The sum of these sectors was calculated based on the DUKES data for the UK, with a proportion for Northern Ireland derived using degree days, population and estimates of building energy efficiency. The split across sub-sectors was estimated based on relative size, with retailing and hotels & catering being the biggest two sectors. Electricity supply data from NIE and Energia was used to construct 'de-minimis' demand totals for sub sectors.

FU 24 to 27: Transport

All of the transport energy use and CO_2 emissions estimates have been derived directly from the 2005 Northern Ireland GHGI, with cross-checking of fuel use data against inland deliveries of petroleum products.

FU 24: Air transport

For FU 24 (air transport), the data are therefore based on flight information from the CAA database on flight movements, which provides detailed data by plane and engine type for all flights originating in Northern Ireland. This analysis is available for the

domestic flights only. This study does not include estimate of emissions from international aviation, which is consistent with the basis of Kyoto and domestic emission targets.

No information has been identified to enable division of these emissions between freight and passenger transport services. Our understanding is that freight and passenger transport is largely combined and therefore impossible to assess separately without significant additional resources to research this matter.

It should be noted that in the case where a business-related journey by air begins with an initial short-haul trip to link up with long-haul connections at other UK or EU airline hubs such as Glasgow or Heathrow, only emissions associated with the initial journey are attributed to Northern Ireland in this analysis.

FU 25: Rail transport

FU 25 (rail transport) emissions are based on fuel use data reported by Translink, the only rail operator in Northern Ireland in 2005.

FU 26: Road transport

The road transport estimates are based on emissions factors derived for the UK fleet combined with road traffic count point data compiled by Department for Regional Development Northern Ireland (DRDNI). The estimates therefore reflect the vehicle kilometres travelled by each different type of vehicle, split up by fuel type (petrol or diesel) and by vehicle type (motorcycle, car, LGV, HGV, buses and coaches). The estimates can therefore be used to inform the approximate division of passenger and freight transport fuel use and emissions.

The road transport estimates are based on vehicle kilometre data within Northern Ireland. Petroleum sales data will not account for fuel bought outside of the UK (eg cross-border sales in ROI due to the differential in sales duty on transport fuels) or illegal use of red or green diesel by vehicles in Northern Ireland.

Road transport emissions are only estimated for journeys in Northern Ireland

Given the methodology of allocating transport emissions to the location of the emission, rather than ultimate 'responsibility', where goods are exported via GB to Europe, or into the ROI, the emissions associated with the distances travelled outside of Northern Ireland have not been estimated here. This would require significant additional study.

Emissions from road freight serve as a proxy of business emissions

Road transport emissions are disaggregated in the following modes;

- cars and motorbikes
- buses
- freight

Due to data limitations, it is not possible to discern the amount of emissions from car, motorbike and bus journeys due to business activities such as commuting. As agreed with the Project Board we will use freight emissions as a proxy for transport emissions from business related activities.

Road freight emissions estimates cannot be disaggregated down to a specific business sector as no data has been identified to enable this. Also, vehicle kilometres or fuel sales data by industry sub-sector have not been found. Obtaining data to this level of detail is beyond the resources of the current study.

FU 27: Shipping

FU 27 (shipping) estimates are based on the UK emissions factors and reported fuel use, with the proportion for Northern Ireland estimated based on port movement data. The estimates for this sector, especially those for international marine transport, are

subject to quite significant error, but no superior data have been identified. Ongoing UK research to improve the quality of marine transport emission estimates should provide updates to Northern Ireland estimates, but not for many months or maybe even years. No information has been identified to enable division of these emissions between freight and passenger transport services for either domestic or international shipping. It seems likely that virtually 100% of international marine emissions ought to be allocated to freight services, whilst domestic shipping will be a combination of freight and passenger transport. The split of road transport passenger vs. freight emissions is perhaps the most appropriate parameter to use to analyse marine transport emissions.

Non-Business Sector estimates

FU 28: Domestic

Energy use and emissions estimates have been calculated using reported domestic fuel-use data from BERR annual energy statistics (DUKES), cross-checked against Northern Ireland GHGI estimates and the top-level fuel-use data from Phoenix Gas, NIE and the coal and petroleum inland deliveries data. The Northern Ireland GHGI data are based on the 2004 BERR regional energy statistics, and also take account of Housing Condition Survey data from HECA reports in 1996, 2001 and 2004. The next HECA report published in early 2008 was not available at time the estimation took place.

FU 1 to 4: Power Generation and Energy industry

Estimates are drawn from the Northern Ireland GHGI based on point source data for these major installations. Since in this study, emissions from electricity consumption are assigned to the fuel user group demanding the electricity, emissions from the power sector are set to zero to avoid double-counting of emissions from the production of electricity.

FU 29 to 31: Public Sector

The estimates for each of the public sector FU groups have been derived from the DFPNI report on public sector energy use from 2004-5.

FU 42: Agriculture

The estimates for agriculture are based on the Northern Ireland GHGI, cross-checked against DUKES petroleum inland delivery data. The estimates for gas use from Phoenix have been re-distributed between agriculture and the food & drink industry as the scale of gas-use reported for the agriculture sector was very high. Considering that the predominantly rural agricultural sector end-users are less likely to have access to the gas network and that the predominantly urban food & drink sector might be expected to use more gas than reported, this exchange of gas use between these related sectors seems a reasonable assumption.

4 Summary of Key Results

This chapter presents estimates of Northern Ireland's fuel consumption and emissions derived from the data and methodology described in Chapters 2 and 3 respectively.

Section 4.1 discusses Northern Ireland's business fuel consumption and CO_2 emissions estimates at a broad level. It also compares economy-wide emission derived in this study with those in the Northern Ireland GHGI.

Section 4.2 compares the Northern Ireland's emissions estimates with those for the UK as a whole.

Section 4.3 presents analysis of Northern Ireland's business emissions and places them in the context of economic data (productivity and growth in gross value added).

Sections 4.4 and 4.5 present comparisons between results for Northern Ireland and other parts of the UK and with other EU countries including ROI.

4.1 Characteristics of Northern Ireland fuel consumption and CO_2 emissions

Northern Ireland's business emissions of CO_2 amounted to at least 6.62 $mtCO_2$ in 2005 or 40% of Northern Ireland's total CO_2 emissions of 16.6 $mtCO_2$.[11]

Table 4.1 below summarises the results for fuel consumption and CO_2 emissions estimated in this study. It shows that Northern Irish businesses were responsible for at least 40% of total CO2 emissions in 2005 (including emissions from road freight transport). This estimate of business emissions is an underestimate as some emissions from other forms of transport (cars, motorcycles, buses, air and sea travel) are also due to business activity. Data limitations prevent us from distinguishing the business element of these.

Nearly 70% of Northern Ireland's business CO_2 emissions are from electricity and road freight.

Chart 4.1 shows the sources of Northern Ireland's business emissions. Obviously, some emissions from road passenger vehicles, rail, air and sea transport should be attributed to businesses as they are connected to business activity, but data limitations do not allow for a sufficiently robust way of disaggregating these emissions.

Road freight is responsible for more than 35% of Northern Ireland's transport CO_2 emissions.

Northern Ireland's transport emissions in 2005 are estimated to have been 5.9 $mtCO_2$, of which around 35% (2.2$mtCO_2$) was due to road freight and therefore business activity. As discussed earlier, business-activity transport emissions will be higher as some emissions from other modes of transport will be due to business activities, but the data do not allow us to distinguish this.

[11] In mtc, these numbers are 1.8 mtc and 4.5 mtc respectively.

Comparison with 2005 Northern Ireland Greenhouse Gas Inventory (NI GHGI)

Table 4.2 compares the fuel and emissions estimate (excluding process emissions) with those in the NI GHGI across the different fuel users for each fuel. The comparison is made for all fuel users, including those that we do not define as being in the 'business sector' in order to be comparable with the NI GHGI.

Electricity For final energy consumption the bottom-up grand total is within 2% of the top-down total based on BERR *Energy Trends* and EU ETS data.

Gas The gas use data presented in this analysis provide an estimate that is very close to the Phoenix Gas sales data. The 2005 NI GHGI data is somewhat lower, and we believe that this is due to an underestimate of 'other industry' gas use within the NI GHGI.

Oils With regard to the use of oil in transport, there seems to be a discrepancy between the data on the importation of oils to Northern Ireland and the estimates of road fuel use that are constructed from transport statistics for the National Air Emissions Inventory (NAEI) (and hence NI GHGI). No doubt some of this difference can be explained by unofficial imports from across the border and illegal consumption to evade fuel duty but the likely remaining difference seems large. In the estimates presented here and used in the database, we have completely relied on the available imports data.

The NI GHGI data on oil use by the agriculture sector seem very high, although this is consistent with recent research to derive off-road fuel use estimates. We have re-allocated some of this oil use in the agriculture sector to the food and drink sector.

Overall, the oil consumption data from this analysis are within 4% of the 2005 NI GHGI data, with some larger discrepancies between individual sector estimates, notably a much higher new estimate of commercial and public sector oil use. The latest BERR Regional Energy Statistics (for 2005) give a much higher estimate for oil use in the domestic sector, which we have disregarded in this study.

Coal The coal consumption data total is close to Northern Ireland coal deliveries statistics. The main discrepancy compared with the 2005 NI GHGI data is the higher estimate for domestic coal use in the bottom-up analysis that we have undertaken. However, the latest BERR Regional Energy Statistics provide a still lower domestic coal fuel-use figure than that presented in the 2005 NI GHGI. This illustrates the variability of data for coal use, where the effects of stockpiling and secondary sales make it difficult to construct accurate annual consumption statistics.

CO_2 emissions Differences between the emissions estimates derived in the present project and the NI GHGI reflect the differences in fuel-use and also the use of Northern Ireland-specific emissions factors rather than the predominant use of UK-average emission factors in the NI GHGI. As noted above, there are some important discrepancies between the NI GHGI data and those derived from sources used in this study, notably for domestic coal use, commercial gas and oil use, domestic oil use and road transport oil use.

TABLE 4.1: BREAKDOWN OF NORTHERN IRELAND FUEL COMSUMPTION AND CO_2 EMISSONS

	Final energy consumption, TWh			CO_2 emissions, mtCO2		
	Direct fuel consumption	Electricity consumption	**Total fuel consumption**	Direct emissions[2]	Emissions from electricity consumption	**Total emissions**
Business sector[3]	6.44	3.95	**10.39**	1.96	2.50	**4.46**
Road freight	7.92		**7.92**	2.16		**2.16**
Business sector plus road freight	14.36	3.95	**18.31**	4.11	2.50	**6.62**
Agriculture	0.35	0.18	**0.52**	0.11	0.07	**0.18**
Other transport[4]	14.71	0.00	**14.71**	3.78		**3.78**
Households	12.28	3.19	**15.47**	3.17	2.02	**5.19**
Public services	1.41	0.84	**2.25**	0.33	0.53	**0.86**
Total	**43.11**	**8.16**	**51.26**	**11.51**	**5.13**	**16.64**

Note(s) : 1.The table shows all final energy consumption and CO_2 emissions, including those attributed to electricity consumption, defined as Fuel Users 5-44 in the table in Appendix C.
2. Direct emissions include process emissions as well as emission from combustion of fuels
3. See table C1 for sectors we include in the business sector
4. Emissions from cars, motorcycles, buses, air and sea travel. Air travel excludes fuel consumed by and emissions from international aviation.

TABLE 4.2: COMPARISON OF RESULTS WITH PREVIOUS ESTIMATES (NI GHGI)

	Final energy consumption, GWh			CO_2 emissions, mt CO_2		
	This project	NI GHGI	Difference as percentage of NI GHGI, %	This project	NI GHGI	Difference as percentage of NI GHGI, %
Electricity	8,157	8,303	-2	5.17	5.26	-2
Gas	3,001	2,543	18	0.56	0.47	18
Coal	4,598	3,511	31	1.48	1.13	31
Oils	34,470	33,135	4	9.04	8.69	4
transport	*22,634*	*19,298*	*17*	*5.93*	*5.06*	*17*
non-transport	*11,836*	*13,837*	*-14*	*3.10*	*3.63*	*-15*
Renewables & waste	1,038	N/A	N/A	0.04	N/A	N/A
Total	**51,263**	**47,492**	**8**	**16.29**	**15.55**	**5**

Note(s) : 1.The table shows all final energy consumption and CO2 emissions, including those attributed to electricity consumption, defined as Fuel Users 5-44 in Table 3.1. Transport excludes international aviation emissions.
2 Excludes process emissions

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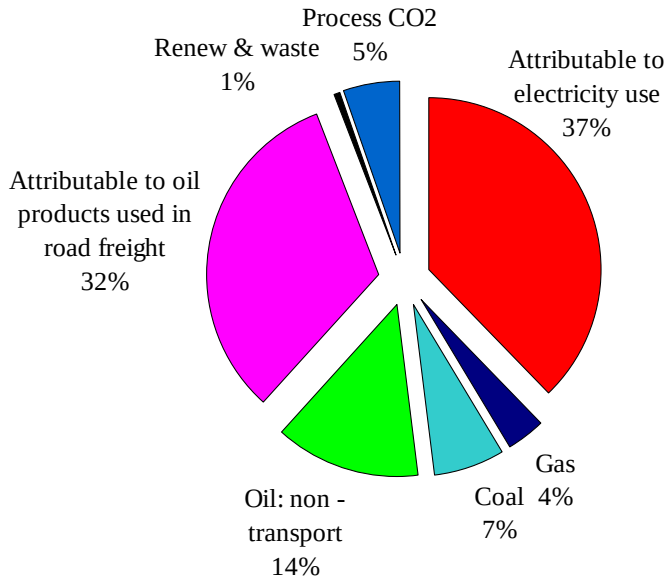
CHART 4.1: SOURCES OF NORTHERN IRISH BUSINESS CO_2 EMISSIONS, 2005



Source(s) : AEA Energy & Environment data prepared for this project.

4.2 Comparison of Northern Ireland's CO_2 emissions with those for the UK as a whole

Charts 4.2 and 4.3 present the general characteristics of the sources of Northern Ireland's CO_2 emissions and compares these with those of the UK as a whole.

Northern Ireland's manufacturing sector is responsible for a smaller share of direct CO_2 emissions than the UK as whole

Chart 4.2 shows the principal sources of direct CO_2 emissions, attributing the emissions from power generation to the 'energy industries' rather than to the end users of electricity. The figure shows that, in Northern Ireland, the share of 'Other industries' (largely manufacturing) as a source of direct (ie excluding those associated with electricity use) emissions is lower than in the UK (10% compared with 18%). Although manufacturing industry accounts for a slightly higher share of the economy of Northern Ireland than is the case for the UK as a whole (in 2004, 16% of total value added, compared with 14½% for the UK[12]), the contribution of the most energy-intensive sectors is smaller in Northern Ireland (for example, manufacturing of paper and pulp, chemicals and basic metals[13]).

The share of road transport in emissions is higher in Northern Ireland than in the UK as a whole (29% compared with 22%). The share of residential emissions is a little higher in Northern Ireland, reflecting higher emissions per capita due to relatively little use of gas at this time and a somewhat colder climate.

Chart 4.3 shows CO_2 emissions by end user, attributing to final users of electricity the CO_2 emissions associated with power generation. The increase from Chart 4.2 in the shares of industry, residential/domestic and commercial/public sectors is larger than for road transport (which dominates the CO_2 emissions from all 'transport' in Chart 4.2) because of the importance of electricity use in those sectors.

Oils play a more prominent part in Northern Ireland's businesses fuel-use

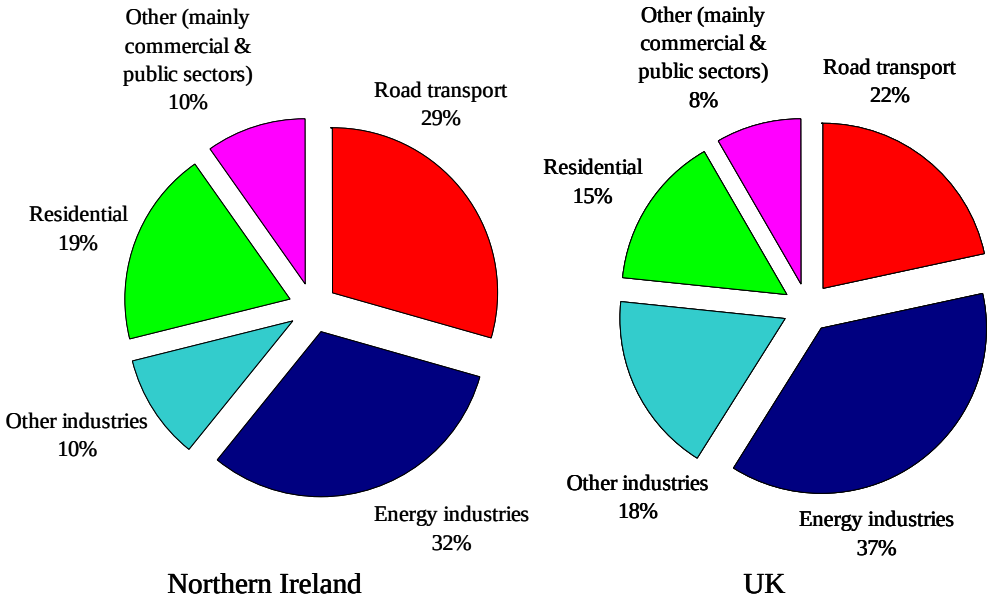
Table D1 in Appendix D presents estimates of the shares of each business sector in our fuel user classification in the final energy market (excluding residential use) for each fossil fuel in Northern Ireland and the UK. The most striking features are:

- the specialised nature of a small number of uses of solid fuels, which differ markedly importance between Northern Ireland and the UK average (more than 90% of solid fuel use in Northern Ireland is in the mineral products sector).
- the greater importance in Northern Ireland of a wide variety of uses of oils (compared with the dominance of road transport uses in the UK as a whole).

[12] Source: Office for National Statistics, UK Regional Accounts, released December 2006, www.statistics.gov.uk/downloads/theme_economy/GVA_Industry_Breakdown_(Headline).xls.

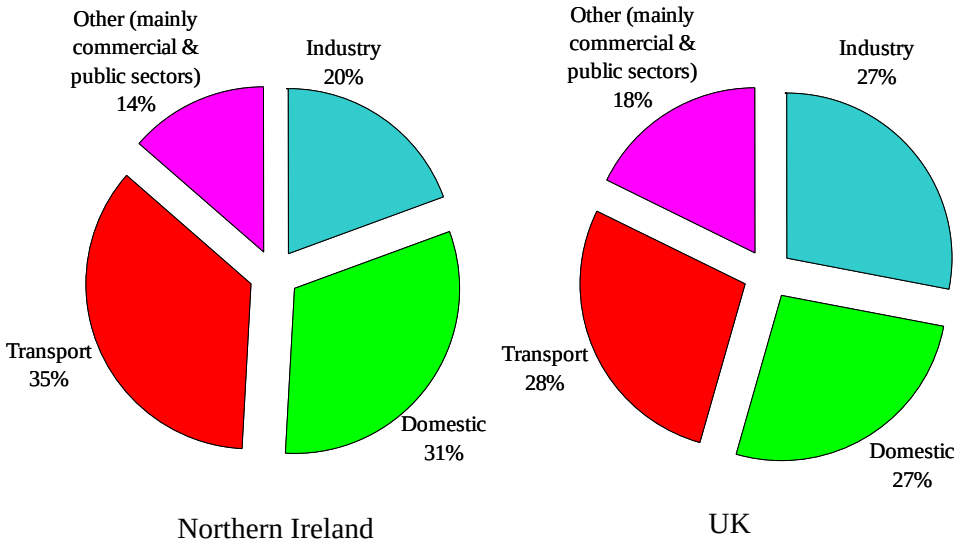
[13] Ibid.

CHART 4..2: CO_2 EMISSIONS BY SOURCE IN NORTHERN IRELAND AND UK, 2005



Source(s) : AEA Energy & Environment data prepared for this project; National Air Emissions Inventory

CHART 4.3: CO_2 BY END USER IN NORTHERN IRELAND AND UK, 2005



Source(s) : AEA Energy & Environment data prepared for this project; National Air Emissions Inventory.

4.3 Analysis of Northern Ireland's business sector CO_2 emissions in the context of economic performance

Sectoral emissions

Charts 4.4 - 4.7 present data for CO_2 emissions and CO_2-intensity of key sectors. We have adopted a common sector classification for these charts. A more detail sectoral breakdown is available for emissions but not for value-added (needed for Charts 4.6 and 4.7). The detail on emissions is included in the database we are providing.

The sectors with the largest CO_2 emissions are distribution, hotels & restaurants and the larger energy-intensive sectors

Chart 4.4 orders the sectors by the scale of their CO_2 emissions (both direct, through the consumption of fossil fuel, and indirect, through their use of electricity). On this measure, large sectors tend to be nearer the top of the list, even if they are not particularly carbon-intensive. This is the case for distribution, hotels & restaurants and education & health. However, Chart 4.5 shows that some energy-intensive sectors are either large enough (in the case of food, drink & tobacco) or energy-intensive enough (in the case of non-metallic mineral products) to feature high in the ranking shown in Chart 4.4. In contrast, some energy-intensive sectors (chemicals, basic metals) are relatively small in Northern Ireland, and so they appear lower in the ranking in Chart 4.4.

The most energy-intensive sectors, shown in Chart 4.5, involve substantial processing of raw materials in manufacturing. The least energy-intensive are services where the use of energy is almost entirely for space heating and office machinery.

Linking emissions and economic data

Charts 4.6 and 4.7 compare the CO_2-intensity of the sectors with economic indicators of interest: productivity and growth in value added over the past decade. Due to a lack of the appropriate data, it has not been possible to compare energy and carbon-intensity of Northern Ireland's business sub-sectors derived in this study with those in other parts of the UK in time for this interim report. We shall conduct this analysis later on in the project when the required data become available.

The financial & business services sector has relatively high productivity and low CO_2-intensity

Chart 4.6 shows that some high productivity sectors have relatively low CO_2-intensity, notably financial & business services and the considerably smaller sector wood, paper, printing & publishing. Textiles, clothing & leather stands out as a sector with relatively low productivity and high CO_2-intensity. Non metallic mineral products has the highest emissions intensity, though it has middle-ranking productivity.

Some of the services are large sectors with relatively low productivity and CO_2-intensity

Notably these are distribution, hotels & restaurants and education & health. Their low productivity is partly because some of the jobs in these sectors are at the low-skill, low-pay end of the spectrum, but also because they have a higher share of part-time work (since the productivity measure is value added per *job*) and because of the difficulty of measuring productivity in the public services.

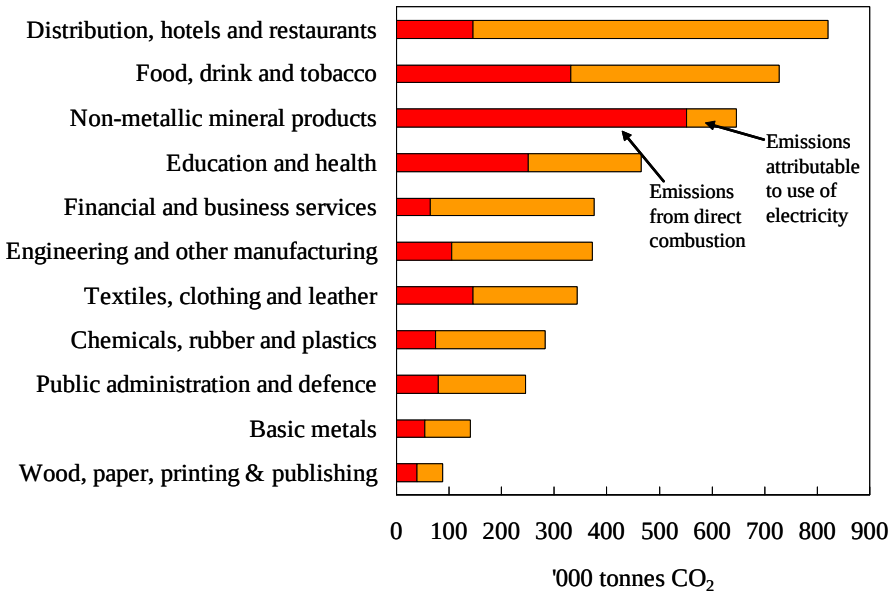
Food & drink is middle-ranking on both CO_2-intensity and productivity

From the point of view of a policy seeking to promote high productivity and low CO_2-intensity, the challenge appears to be greatest in food, drink & tobacco and the much smaller chemicals & plastics sector, since these sectors rank quite highly on both productivity and CO_2-intensity.

Structural change over 1994-2004 has partly favoured low CO_2-intensity sectors

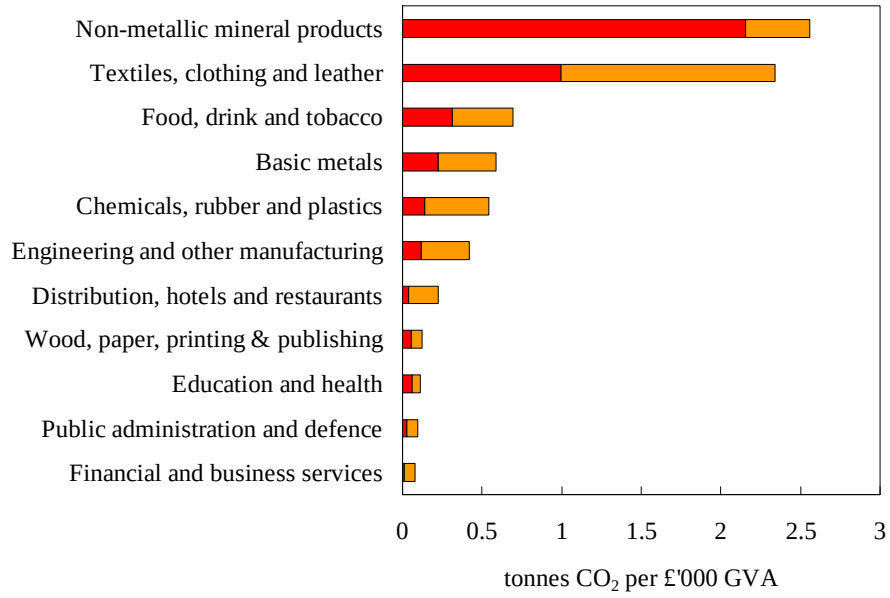
Chart 4.7 allows a comparison of the sectors on their long-term rates of growth in value added as well as CO_2-intensity. The decline in value added of the (now small) textiles, clothing and leather sector has been helpful in curbing CO_2 emissions since it is CO_2-intensive. Similarly, the strong structural shift in favour of financial & business services has supported strong growth in value added with relatively low impact in terms of CO_2. Again, non metallic mineral products has the highest emissions intensity, though it has achieved middle-ranking growth. Growth in value added has generally been rather slower, although far from negligible, in the more CO_2-intensive sectors.

CHART 4..4: PRINCIPAL SOURCES OF CO_2 EMISSIONS IN NORTHERN IRELAND, 2005



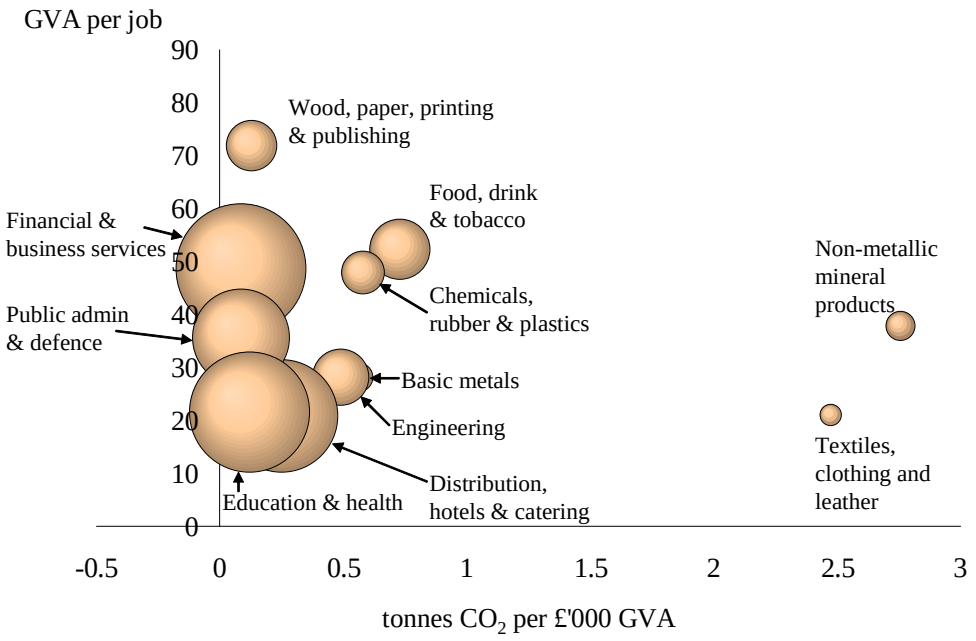
Source(s) : AEA Energy & Environment data prepared for this project.

CHART 4.5: CO_2-INTENSITY OF PRODUCTION AMONG SECTORS IN NORTHERN IRELAND, 2005[1]



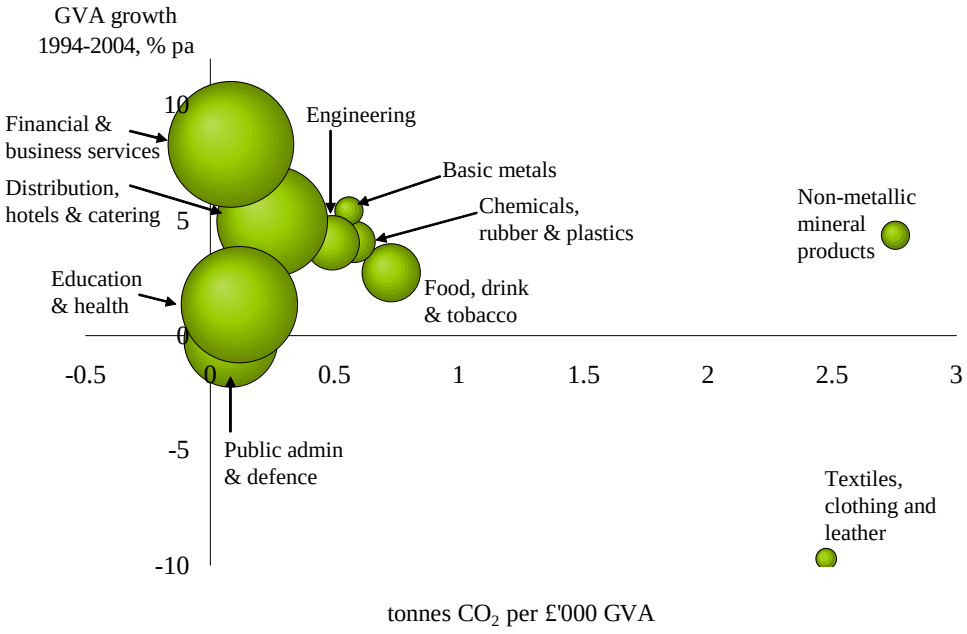
Note(s) : 1. GVA data used in the denominator are 'headline' data for 2004, as data for 2005 was not released when data this chart was first compiled.
Source(s) : AEA Energy & Environment data prepared for this project; ONS Regional Accounts.

CHART 4.6: CO_2-INTENSITY AND PRODUCTIVITY AMONG SECTORS IN NORTHERN IRELAND, 2005[1]



Note(s) : 1. GVA data used in the denominator are 'headline' data for 2004, as data for 2005 was not released when data this chart was first compiled.. Jobs data are for 2004 and include an estimate for self-employment.
2. The size of the bubbles is proportional to the GVA of the sector in 2004.

CHART 4.7: CO_2-INTENSITY AND GVA GROWTH AMONG SECTORS IN NORTHERN IRELAND, 1994-2004[1]



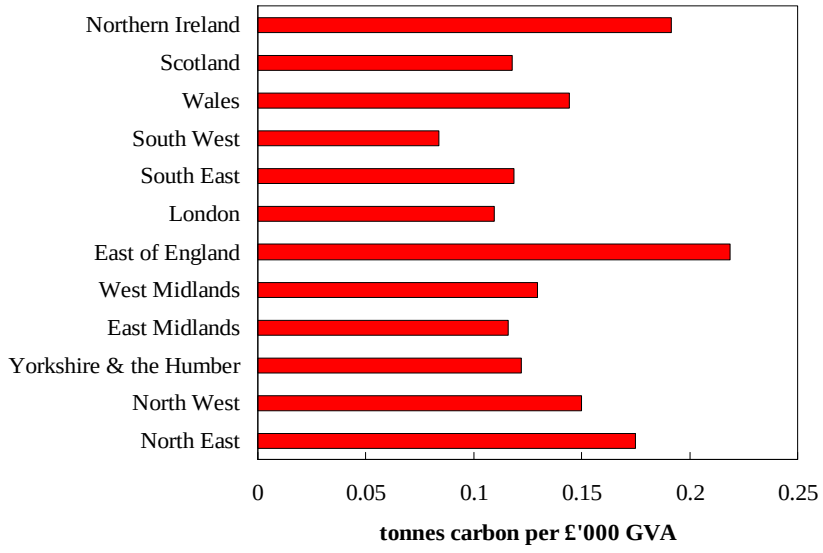
Note(s) : 1. GVA growth over 1994-2004 is estimated chained volume measure, using UK data for sectoral deflators. CO2 intensity is 2005 CO2 emissions divided by 20
2. CO2 is measured as tonnes of carbon.

4.4 Benchmarking against other parts of the UK

The quality of data available to conduct a benchmarking exercise against other parts of the UK is not high. The work undertaken for this study has developed a database for Northern Ireland, but comparable work has not been undertaken for the other UK countries and for the regions of England. The SCPnet consortium[14] commissioned Cambridge Econometrics and AEA to develop data for these areas for 2005[15], and this work comprised an analysis of the data collected for the National Air Emissions Inventory together with supplementary analysis using UK sources. However, unlike the present study, the work did not involve consulting sources available within each nation/region. Consequently, comparisons between the data developed under the present study and the SCPnet data should be regarded as indicative rather than definitive.

The following charts present comparisons for selected industries. In each case the data show the ratio of carbon emissions (both direct emissions from the use of fossil fuel and indirect emissions attributable to electricity use) to value added in 2005. Differences among regions/nations may reflect differences in energy efficiency, differences in productivity (higher value added per worker regions such as London will typically have a lower intensity of energy use and hence of carbon emissions) or diffiences in the kind of activity undertaken (the large differences among regions in carbon emissions per unit of value added in basic metals reflect the location of the UK's major steel plants in the North East, Yorkshire & the Humber and Wales, which are far more energy and carbon intensive than the other activities classified to basic metals and which are characteristic of other regions).

CHART 4.8: CO_2-INTENSITY IN FOOD, DRINK AND TOBACCO, 2005

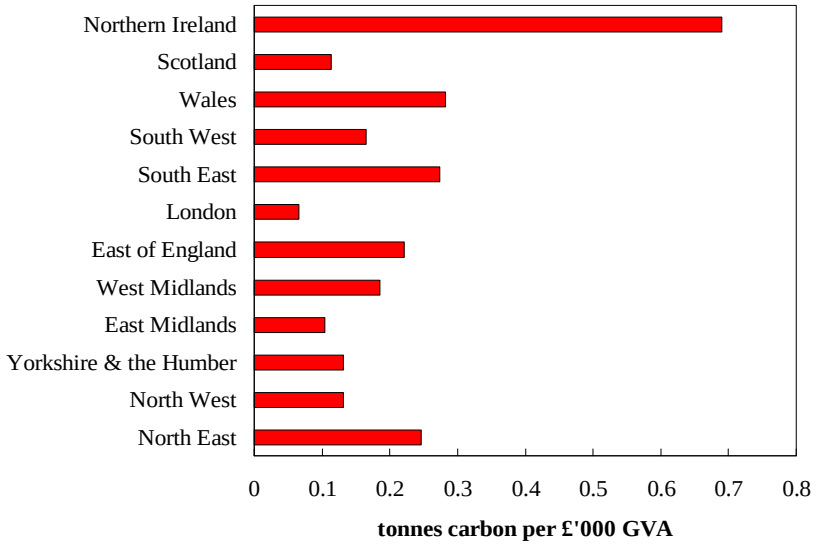


Note(s) : 1. GVA data used in the denominator are 'headline' data for 2005
2. CO2 is measured as tonnes of carbon.
Source(s) : NI data: AEA Energy & Environment data prepared for this project; other areas: SCPnet air emissions and energy database; ONS Regional Accounts.

[14] See www.scpnet.org.uk.

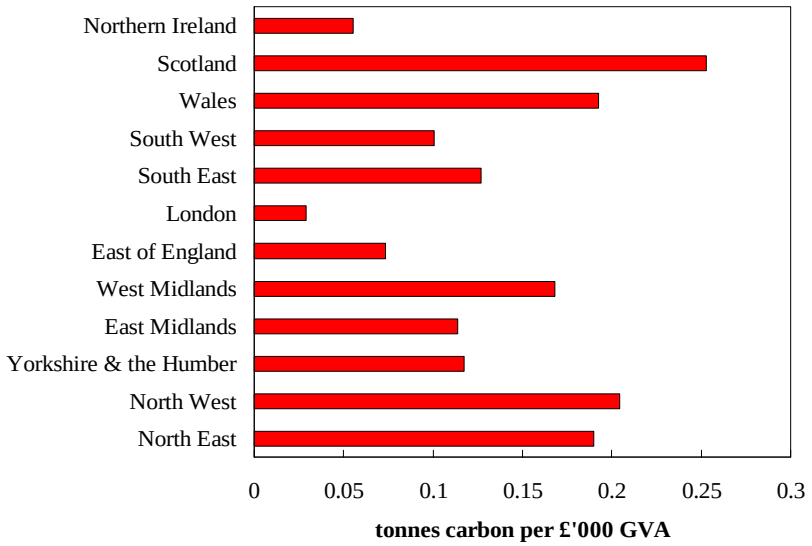
[15] www.scpnet.org.uk/environmental-data.html.

CHART 4.9: CO_2-INTENSITY IN TEXTILES, CLOTHING AND LEATHER 2005



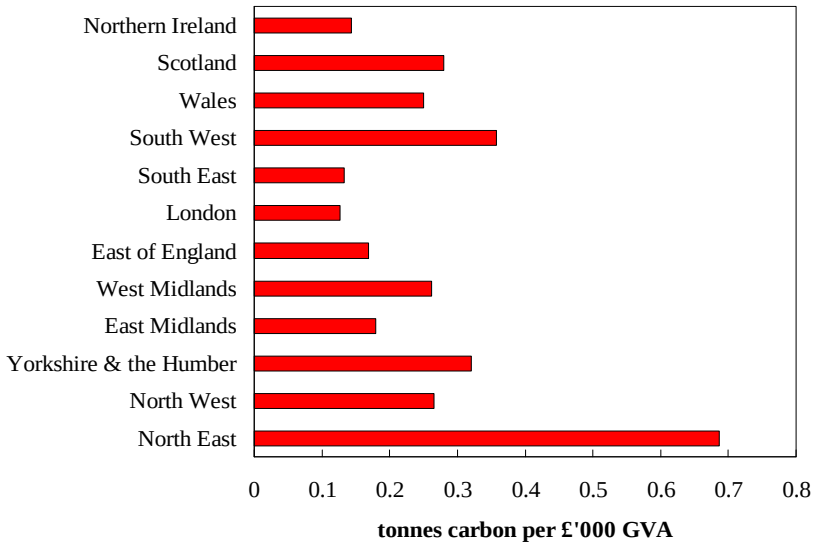
Note(s) : 1. GVA data used in the denominator are 'headline' data for 2005
2. CO2 is measured as tonnes of carbon.
Source(s) : NI data: AEA Energy & Environment data prepared for this project; other areas: SCPnet air emissions and energy database; ONS Regional Accounts.

CHART 4.10: CO_2-INTENSITY IN WOOD, PAPER, PRINTING AND PUBLISHING, 2005



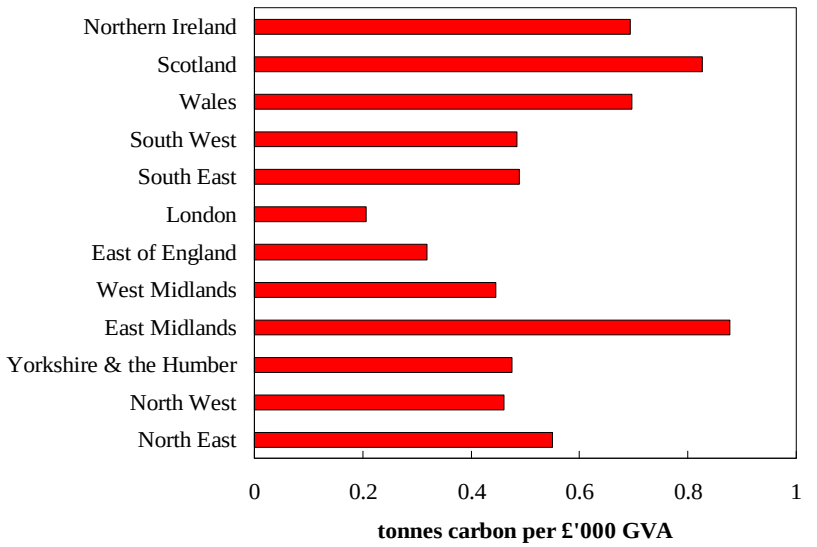
Note(s) : 1. GVA data used in the denominator are 'headline' data for 2005
2. CO2 is measured as tonnes of carbon.
Source(s) : NI data: AEA Energy & Environment data prepared for this project; other areas: SCPnet air emissions and energy database; ONS Regional Accounts.

CHART 4.11: CO_2-INTENSITY IN CHEMICALS, RUBBER AND PLASTICS, 2005



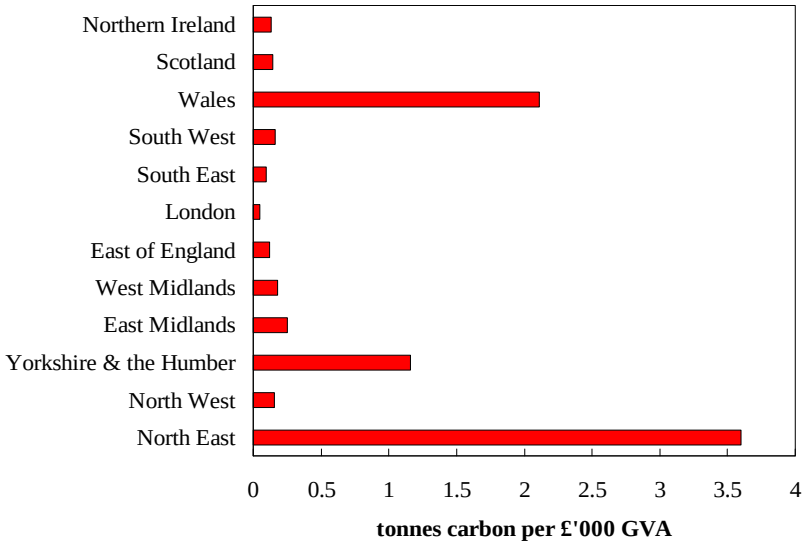
Note(s) : 1. GVA data used in the denominator are 'headline' data for 2005
2. CO2 is measured as tonnes of carbon.
Source(s) : NI data: AEA Energy & Environment data prepared for this project; other areas: SCPnet air emissions and energy database; ONS Regional Accounts.

CHART 4.12: CO_2-INTENSITY IN NON-METALLIC MINERAL PRODUCTS, 2005



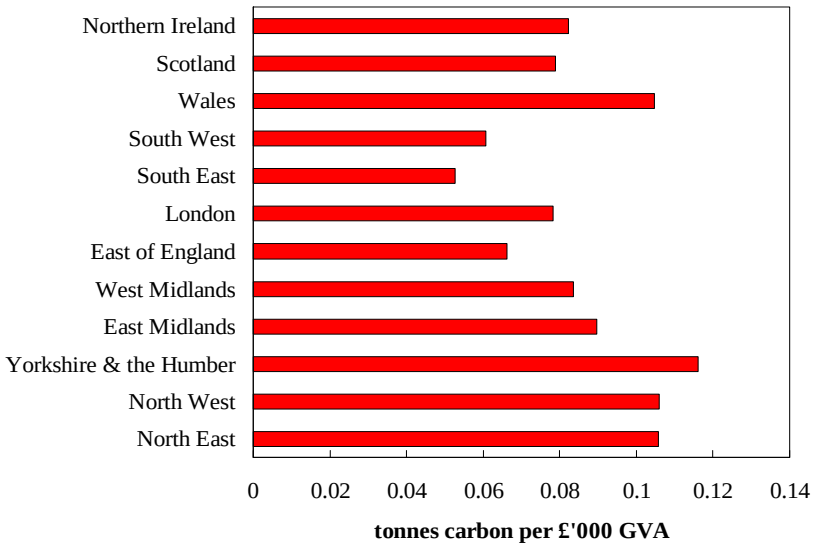
Note(s) : 1. GVA data used in the denominator are 'headline' data for 2005
2. CO2 is measured as tonnes of carbon.
Source(s) : NI data: AEA Energy & Environment data prepared for this project; other areas: SCPnet air emissions and energy database; ONS Regional Accounts.

CHART 4.13: CO_2-INTENSITY IN BASIC METALS, 2005



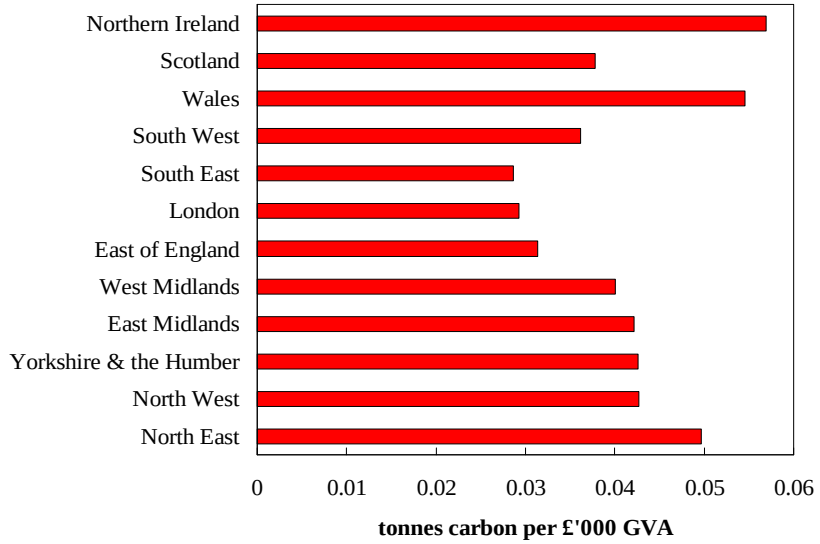
Note(s) : 1. GVA data used in the denominator are 'headline' data for 2005
2. CO2 is measured as tonnes of carbon.
Source(s) : NI data: AEA Energy & Environment data prepared for this project; other areas: SCPnet air emissions and energy database; ONS Regional Accounts.

CHART 4.14: CO_2-INTENSITY IN ENGINEERING AND OTHER MANUFACTURING, 2005



Note(s) : 1. GVA data used in the denominator are 'headline' data for 2005
2. CO2 is measured as tonnes of carbon.
Source(s) : NI data: AEA Energy & Environment data prepared for this project; other areas: SCPnet air emissions and energy database; ONS Regional Accounts.

CHART 4.15: CO_2-INTENSITY IN DISTRIBUTION, HOTELS AND RESTAURANTS, 2005



Note(s) : 1. GVA data used in the denominator are 'headline' data for 2005
2. CO2 is measured as tonnes of carbon.
Source(s) : NI data: AEA Energy & Environment data prepared for this project; other areas: SCPnet air emissions and energy database; ONS Regional Accounts.

CHART 4.8: CO_2-INTENSITY IN FINANCIAL AND BUSINESS SERVICES, 2005

Note(s) : 1. GVA data used in the denominator are 'headline' data for 2005
2. CO2 is measured as tonnes of carbon.
Source(s) : NI data: AEA Energy & Environment data prepared for this project; other areas: SCPnet air emissions and energy database; ONS Regional Accounts.

4.5 Benchmarking against other EU Member States

The project team has initiated consultation across Europe to identify potential datasets for use by DETI to benchmark Northern Ireland energy use and CO_2 emission patterns in the business sector. Experts in GHG inventory compilation, EU ETS data compilation and energy efficiency data compilation have been approached to obtain any detailed industry and commercial sector energy use / CO_2 emissions data. These individuals and organisations are acknowledged in Chapter 1.

Several sources of data have been investigated, as follows.

- No examples of detailed energy and emissions analysis (at a greater level of detail than the IPCC reporting structure currently used in Northern Ireland) have been identified via the EEA WG1 members
- EU ETS data from across other Member States are available on a site-by-site basis, but the usefulness of these data is limited as they do not represent 100% coverage of any given sector
- Headline data on sector-specific energy use trends have been identified via the ODYSSEE project
- Analysis against the ONS Air Accounts has been conducted for the non-electricity energy use

Insofar as the purpose of benchmarking is to learn lessons that may be relevant for targeting opportunities for improvement in energy efficiency or CO_2 emissions in Northern Ireland, it is important to review data for specific industrial and commercial sectors, because the aggregate results for Member States are heavily influenced by:

- the different generation mix for electricity production across different countries, commonly determined by the local availability of fuels and technologies
- the different industrial composition / heritage of the different states

Of course, these factors would be relevant considerations if the purpose of benchmarking were to compare the exposure of a country or region to more stringent CO_2 targets in the future.

Transport in Northern Ireland demands a much higher proportion of energy

Table 4.3 presents comparative data for energy use by broad sectors in Northern Ireland and selected other countries. The most pronounced differences are for transport use, where it constitutes a much higher proportion of fuel demand in Northern Ireland (44%) than in the other three countries (30-33%). Northern Ireland's industry and services (25%) demand a lower share of energy compared to the share in the other three countries (34-41%).

The food and drinks and textile sectors constitute a much higher proportion of industrial energy demand

Table 4.4 presents some comparative data on energy use broken down by manufacturing sectors. Unfortunately, the classifications vary across the different sources and so it is difficult to make precise comparisons. The relatively low importance of basic metals chemicals, rubber and plastics in Northern Ireland is clear, as is the greater importance of food & drink and textiles, clothing and leather.

TABLE 4.3: COMPARISON OF SHARES OF BROAD USERS IN ENERGY CONSUMPTION

	Ireland %	Denmark %	Germany %	N. Ireland %
Industry	22	18	27	15
Transport	33	32	29	44
Residential	25	29	29	30
Agriculture	3	5	1	1
Services & other	18	16	14	10
Total	100	100	100	100

Source(s) : NI data, this project. Odyssee project national reports (2006) for other countries.

TABLE 4.4: SHARES OF MINING AND MANUFACTURING SECTORS IN INDUSTRIAL ENERGY CONSUMPTION

Germany	2004 %	Ireland	2004 %	N Ireland	2005 %
		Mining	5	Mining	4
Iron & steel	26	Basic metals	21	Basic metals	3
Non-ferrous metals	4	Non-ferrous metals	21		
Cement	5			Minerals	24
Glass	3				
Chemicals	18	Chemicals	10		
		Rubber & plastics	2	Rubber & plastics	6
Machinery	15	Machinery	1		
		Electrical equipment	8	Electronics	4
Food & drink	8	Food & drink	20	Food & drink	26
Paper & pulp	8	Paper & pulp	2		
		Wood	5	Wood & paper	4
Other	13	Textiles	1	Textiles, clothing & leather	12
				Water supply	3
		Other	3	Other	14
Total	100		100		100

Source(s) : NI data, this project. Odyssee project national reports (2006) for other countries.

5 Recommendations for Future Data Gathering

5.1 Lessons from the sources used in the present project

The AEA team considered the analysis of existing resources and compiled a number of recommendations for the consideration of the Project Board, aimed at the further enhancement of data collection mechanisms to address information gaps, which will allow for an improved understanding, and facilitate regular and robust monitoring, of GHG emissions from Northern Ireland's businesses.

The main issues identified are discussed briefly below.

A lack of data on direct emissions from businesses not covered in the EU ETS

Regular, systematic, direct reporting on emissions occurs only for installations regulated under the EU ETS. Apart from power generation, which has large plants comprehensively covered by the EU ETS, the coverage is limited to a relatively small number of highly fossil fuel-intensive processes. Since future UK policy developments are shifting their focus to installations and firms not in the EU ETS, this group is also likely to be the focus of any Northern Ireland-specific policies. The lack of data on these energy users is a particular weakness with regard to future monitoring. Another possible source of information for selected installations, those covered by CCAs, could not be used because this would breach confidentiality agreements.

Information available from electricity suppliers can be detailed though it was still not sufficient

Electricity suppliers do seem to have detailed information about the breakdown of their customers. However, this data was still broader than the fuel user categories used by the REEIO model. There was also some discrepancy between the total derived from the suppliers and the total estimated by the regulator NIAUR.

Information available from the gas supplier is only useful for broad aggregates

The gas supplier did not have information beyond 'residential' and 'industrial & commercial' (and even these estimates may be based on the scale of consumption). In addition this information is not usually available in this format. For example, for this study a bespoke data collection exercise had to be undertaken by the supplier.

This is expected to continue into the future. There is typically no SIC coding to allow for the identification of the industrial sector of a particular fuel user. Where the supply is not through fixed networks (as for electricity and natural gas), estimates of the supply itself can be uncertain (this is very much the case for petroleum products and road transport fuels).

It is difficult to distinguish the emissions from transport fuel attributable to business activities

Current UK data collection systems are designed to discern mode of transport, but not the reason for travel. Consequently, it is not possible (for example) to distinguish the extent to which air passenger transport is for the business sector. There is also the conceptual difficulty of determining whether the emissions from transport travelling outside of Northern Ireland but to deliver imports or exports to Northern Ireland should be attributed to Northern Ireland's business. In the estimates presented here, these are not included.

5.2 Detailed issues relating to specific sources of data

In this section we note some specific, detailed issues that we encountered as we prepared the estimates of energy use and CO_2 emissions. Since the 'jig-saw' approach involves a comparison of bottom-up demand estimates with supply estimates in a simple form of energy balance, we include issues that extend beyond the business sector (because the balance requires estimates for all kinds of energy use).

Emissions from road transport.

There are three issues with this:

1 BERR's fuel delivery statistics gives a much-distorted picture. It is recognised that there is considerable invisible importing of petrol and diesel from ROI – ie filling up before crossing the border because duty in ROI is considerably less than in Northern Ireland. It is likely that nearly all regular freight or passenger transport between ROI and Northern Ireland will not be classified as Northern Irish consumption.

2 Illegal stripping of 'red' or 'green' diesel for non-agricultural uses.

3 Neither fuel import statistics nor road-kilometres driven statistics will give the full picture of total energy costs associated with transporting goods or people from Northern Ireland across ROI/rest of UK etc. In particular, goods exported to Europe or beyond will only have a small portion of their total energy requirements attributable to Northern Ireland and this may give a misleading view of the total transport footprint.[16]

Emissions from air transport (passenger and freight)

Two main issues arise:

1 It is difficult to disaggregate energy used for passengers and goods; often the same plane is used for both.

2 Again, statistics will not give the complete picture. In particular, long haul journeys that may originate in Northern Ireland but start with only a short-haul flight to (say) Heathrow, Manchester, Paris or elsewhere.

Emissions from sea/ shipping transport (both national and international)

As with air transport, it is difficult to disaggregate energy used for passengers and goods.

Industrial combustion outside of power generation.

Two main issues arise:

1 There is little systematic data-gathering on the consumption of energy and fuel that distinguishes between industrial and commercial operators.[17]

2 Even for larger industrial sites, total energy consumption and fuel split are not explicitly declared in the public domain. Some sources give partial information that requires back-calculation; for instance EU ETS gives a total energy plus process CO_2 emission figure (which needs disaggregating), but provides no data on consumption and indirect CO_2 emissions from electricity (which needs estimating).

[16] Given NI's location, the reverse will not be true, ie goods do not get shipped across NI.

[17] The most recent systematic gather was in 2003, of 2002 data. Even this is recognised as being incomplete and, given the dynamic nature of energy supply in Northern Ireland, quickly gets out of date.

This study was not able to consider monitoring information of CCAs which would have provided fuel consumption of large installations typically captured by this scheme. We were not able to use this as we would have breached confidentiality rules which govern the dissemination of these data. In any case this data would only report the large installations which are captured by this policy and would not provide any information on smaller sites not included in the scheme.

Residential sector

We used the electricity and gas suppliers' consumption figures as fixed points (although these can be misleading). Total and other fuel splits were back-estimated from UK statistics. Estimates took account of known differences in fuel availability, climate conditions, building stock, etc and adjusted and split making use of the known electricity and gas figures.

Renewable energy for electricity generation

This is well regulated; however, direct renewable consumption is very difficult to track.[18]

Data on the supply of energy

There are several sources of fuel supply and consumption data from within the Northern Ireland and UK governments, such as:

- shipments of coal into Northern Ireland (DETI annual publication)
- petroleum deliveries for Northern Ireland consumption (BERR annual publication)
- electricity generated (and from which primary fuel), imported/ exported and consumed within Northern Ireland

However, it appears that the data presented for coal shipments includes data for all solid fuels imported and these are not currently available at a sufficiently detailed level. Nor is there any sector-specific estimate of end-use of the solid fuels. The petroleum delivery data does provide a breakdown of specific fuel imports but again does not provide any data on the end-use of these fuels. Therefore, these resources can, and have, been used to provide indicative annual consumption figures for Northern Ireland as a whole rather than definitive figures.

As an illustration of the difficulty in matching up supply and demand estimates, we found a large discrepancy for 2005 between estimates of the supply and demand (on a bottom-up basis) for electricity of the order of 500 GWh (6-7%).

5.3 Recommendations for future improvement

The following recommendations are intended to enhance data collection mechanisms so as to address the information gaps and issues identified above, with the overriding aim of allowing an improved understanding and *regular* and *robust* monitoring of GHG emissions from Northern Ireland's businesses in the future.

[18] For instance, increase use of natural light v. artificial light, use of washing lines versus. tumble dryers, etc.

To improve estimates of fuel use by business, and hence CO2 emissions, we recommend an extension of the questions in Annual Business Inquiry to cover energy consumption by fuel type

Although a broad picture of energy use and CO_2 emissions can be built up by the 'jigsaw' approach adopted here, the scale of the potential errors in this exercise are such that it does not represent an adequate method for measuring year-on-year changes in CO_2 emissions by business. Nor does it allow adequate monitoring of energy-use by detailed sector, which is an important indicator for assessing the effectiveness of policies targeted at particular sectors.

The counter-argument to this recommendation is that it imposes an additional reporting burden on business. Our response to this is two-fold. Firstly, it would not impose any additional burden for large installations that already have to report under the EU ETS or CCAs. Secondly, if we are to be successful in curbing CO_2 emissions it is clearly essential for businesses to be aware of what their energy use is. In this case, a requirement to report energy consumption supports the goal of promoting awareness of energy consumption, which is the first step towards encouraging greater energy efficiency. We already require business to report statistics for turnover, value added and employment; the imperative to curb CO_2 emissions seems sufficiently important to warrant the imposition of this modest additional reporting burden.

If such direct reporting of energy consumption were introduced, a proper analysis of energy consumption would still require an exercise to construct an energy balance to cross-check the survey results. However, the derivation of estimates from such a process would be much easier to compile and more robust if survey data were available.

Conducting regular studies akin to the 2002 Northern Ireland Energy Study

If extension of the ABI were rejected as a policy option, then we suggest that, as a second-best solution, a study of the same kind as the Carbon Trust's *2002 Northern Ireland Energy Study* be undertaken on a regular basis. The 2002 study provided the best source of comprehensive data on fuel-use by industry sector for estimates for this project. However, the scale of the task of corroborating the various data sources would probably rule out the prospect of undertaking such a study on an annual basis.

Other suggested improvements

We make here a number of other recommendations arising from the observation of specific weaknesses in the data. Some of these are directly relevant to the business sector while others address important elements of the wider energy balance picture.

1 Assess the full impact of transport of goods and/or people that originate in Northern Ireland but do not entirely take place in Northern Ireland (ie total fuel-kilometres driven, flown or shipped by goods and/or people, considering the whole journey and not just the first leg or only the in-country part of a journey).

2 Assess the composition of Northern Ireland's vehicle fleet and survey transport movements to obtain more data on cross-border movements. Where possible, estimates of cross-border fuel sales should be made.

3 Research road transport movements on minor roads.

4 Conduct research to investigate the fuel-use and emissions from national and international shipping sources, to enable better estimation of the emissions associated with import and export of materials (as well as passengers).

5 Develop a more detailed annual system of recording fuel imports to determine fuel-specific information (ie import data for coal, anthracite, petroleum coke, Solid Smokeless Fuel, kerosene, gas oil, fuel oil, waste-derived oil and solvents, wood). Currently, the information available on solid and petroleum fuels appears to be inconsistently detailed.

6 Improve the detail and frequency of agriculture surveys, to include more information on local animal, fertiliser and waste management practices.

7 Conduct periodic, detailed assessments of fuel markets to provide more detailed information on the end-use, export, and bunkering of fuels, especially for the domestic sector, where sales of all fuels are subject to uncertainty. This even applies to gas, where estimates are made based on annual consumer use. Hence, some small commercial gas users may be incorrectly assigned to the domestic sector.

8 In order that electricity generation and consumption patterns are better understood (the latest BERR electricity data for Northern Ireland has some large discrepancies between supply and demand-side data), it is recommended that closer monitoring of electricity imports, exports and Northern Ireland consumption is implemented. This will be essential in future to support more accurate determination of end-user emissions data, in particular the CO_2/kWh factor for delivered electricity in Northern Ireland.

Appendix A: Acronyms and Abbreviations

ABI	Annual Business Inquiry
BAU	Business as usual
CCA	Climate Change Agreement
CCGT	Combined cycle gas turbine
CCL	Climate Change Levy
CDM	Clean Development Mechanism (of the Kyoto Protocol)
CE	Cambridge Econometrics
CHP	Combined heat and power
CRC	Carbon Reduction Commitment
CTNI	The Carbon Trust in Northern Ireland
DETI	Department of Enterprise, Trade and Investment
DFPNI	Department of Finance & Personnel Northern Ireland
DoE	Department of Environment (Northern Ireland)
DRDNI	Department for Regional Development Northern Ireland
DUKES	Digest of UK Energy Statistics
EU ETS	European Union Emissions Trading Scheme
FGD	Flue gas desulphurisation
FU	Fuel user
GHG	Greenhouse gases
GHGI	Greenhouse gas inventory
HECA	Home Energy Conservation Act
IPPC	Integrated Pollution Prevention and Control
IPCC	Intergovernmental Panel on Climate Change
LA-IPPC	Local Authority Integrated Pollution Prevention and Control
LPG	Liquefied petroleum gas
NAEI	National Air Emissions Inventory
NI	Northern Ireland
NIE	Northern Ireland Electricity
NIHE	Northern Ireland Housing Executive
ONS	Office for National Statistics
REEIO	Regional Energy Environment Input Output Model
RoI	Republic of Ireland
SIC	Standard Industrial Classification

WML	Waste Management Licensing

Appendix B: Uncertainty in the Northern Ireland Greenhouse Gas Inventory

TABLE B1: UNCERTAINTY ASSOCIATED WITH THE TOP 20 GHG EMISSION SOURCE SECTORS IN THE 1990-2005 NI GHG INVENTORY

Share in NI GHG emissions 2005 (%)	Source	Gas	Assessment of overall uncertainty
25%	Power stations	CO_2	Low. Includes some consideration of EU ETS data. Could be small improvement using NI-specific Efs.
22%	Road transport	CO_2	Okay. Some improvements could be made to refine to suit NI-specific fleet and more detailed minor road data.
13%	Residential combustion	CO_2	Okay to poor. Despite the use of HECA reports, there is still significant uncertainty in the level of emissions from this sector.
10%	Agricultural soils	N_2O	Poor. Uncertainty regarding Efs and extent of survey data.
9%	Enteric fermentation - cattle	CH_4	Okay. Uncertainty regarding Efs and extent of survey and detail of survey data.
6%	Other industrial combustion	CO_2	Okay to poor. Need to develop more data on fuel use across NI,
6%	Land converted to cropland	CO_2	Okay. Based on periodic land survey data and annual revision of Efs and methods.
3%	Land converted to settlements	CO_2	Okay. Based on periodic land survey data and annual revision of Efs and methods.
2%	Agricultural combustion	CO_2	Okay, but could be improved by more research into NI agriculture mobile machinery fuel use.
2%	Cement - decarbonising	CO_2	Low. Includes some consideration of EU ETS data.
1%	Landfill	CH_4	Okay to Poor. Uncertain UK-level modelled data, plus no detailed local data on site-specific methane management.
1%	Cattle wastes	CH_4	Okay to poor. Uncertainty regarding Efs and extent of survey and detail of survey data.
1%	Commercial combustion	CO_2	Okay to poor. Need more local data, but the uncertainties are less significant than for residential and other industry sources.
1%	Domestic aircraft	CO_2	Low. Good quality aircraft movements database. May be some missing data but not significant.
1%	Enteric fermentation - sheep	CH_4	Okay. Uncertainty regarding Efs and extent of survey and detail of survey data.
1%	Road transport	N_2O	Okay. Some improvements could be made to refine to suit NI-specific fleet and more detailed minor road data.
1%	Coastal shipping	CO_2	Poor. Combination of poor activity data at UK level and NI level.
1%	Manure solid storage	N_2O	Okay to poor. Uncertainty regarding Efs and extent of survey and detail of survey data.
1%	Refrigeration	HFCs	Okay to poor. Lots of areas where there simply isn't source data.
0%	Grassland - biomass burning	CO_2	Okay. Based on periodic land survey data and annual revision of Efs and methods.

Source(s) : AEA Energy & Environment assessment of Northern Ireland Greenhouse Gas Inventory.

Appendix C: REEIO Sector Classifications

TABLE C.1: FUEL USER CLASSIFICATION, BUSINESS SECTOR

Fuel user category		SIC 2003 (where relevant)
5	Basic metals	27
6	Mineral products	26
7	Chemicals	24 (excl 24.4)
8	Pharmaceuticals	24.4
9	Mechanical engineering	29
10	Metal goods	28
11	Electronics	30,32
12	Electrical engineering & instruments	31,33
13	Motor vehicles	34
14	Other transport equipment	35
15	Food, drink & tobacco	15,16
16	Textiles, clothing & leather	17, 18, 19
17	Paper, printing & publishing	21,22
18	Other mining	13,14
19	Wood & wood products	20,21
20	Rubber & plastics	25
21	Manufacturing nes & recycling	36,37
23	Construction	45
32	Retailing	52
33	Distribution nes	50, 51
34	Hotels & catering	55
35	Other transport services	
36	Communications	64
37	Banking & finance	65, 67
38	Insurance	66
39	Computing services	72
40	Professional services	70, 71, 73, 74.1-74.4
41	Other business services	74.5-74.8
43	Miscellaneous services	90-93, 95, 99
44	Miscellaneous	

Source (s): Cambridge Econometrics, ONS

TABLE C2: FUEL USER CLASSIFICATION, NON-BUSINESS SECTORS

Fuel user category		SIC 2003 (where relevant)
1	Power generation	
2	Other energy transformation	
3	Energy industries' own use: electricity generation	
4	Energy industries' own use: other	
22	Water supply	41
24	Air transport	62
25	Rail transport	
26	Road transport	
27	National navigation and pipelines	
28	Domestic use (households)	
29	Public administration & defence	75
30	Education	80
31	Health & social work	85
42	Agriculture	01,02,05

Source (s): Cambridge Econometrics, ONS

Appendix D: Fuel Consumption in Northern Ireland and the UK

TABLE D1: SHARES OF EACH SECTOR IN THE MARKET FOR SELECTED FOSSIL FUELS, 2005

		Northern Ireland			UK		
Fuel user category	Sector	Gas	Solid fuels	Oils	Gas	Solid fuels	Oils
5	Basic metals	5.1	0.1	0.3	4.6	34.4	0.6
6	Mineral products	0.0	92.6	1.3	4.2	25.2	1.0
7	Chemicals	0.5	0.0	0.2	14.7	14.7	1.7
8	Pharmaceuticals	0.6	0.0	0.2	2.7	0.0	0.1
9	Mechanical engineering	0.6	0.0	0.1	1.3	0.0	0.9
10	Metal goods	4.9	0.0	0.0	1.7	0.2	0.9
11	Electronics	1.0	0.0	0.1	0.4	0.0	0.2
12	Electrical engineering & Instruments	0.0	0.0	0.2	1.0	0.0	0.4
13	Motor vehicles	4.5	0.0	0.1	2.6	1.6	0.3
14	Other Transport Equipment	4.6	0.0	0.3	1.2	0.6	0.3
15	Food, Drink & Tobacco	10.8	0.0	4.1	10.1	6.4	2.4
16	Textiles, clothing & leather	7.3	0.0	1.7	2.5	1.9	0.7
17	Paper, printing & publishing	0.0	0.0	0.2	7.9	5.1	0.9
18	Other mining	1.0	0.0	0.9	0.4	0.0	0.6
19	Wood & wood products	0.0	0.0	0.3	0.7	0.0	0.8
20	Rubber & plastics	0.5	0.0	0.6	1.5	4.3	1.8
21	Manufacturing nes & recycling	0.2	0.0	0.0	1.4	0.0	1.8
22	Water supply	0.0	0.0	0.0	0.0	0.0	0.7
23	Construction	0.0	0.0	0.0	0.0	0.0	7.6
24	Air transport	0.0	0.0	8.0	0.0	0.0	27.1
25	Rail transport	0.0	0.0	0.3	0.0	0.0	1.5
26	Road transport	0.0	0.0	69.5	2.2	0.0	18.4
27	National navigation and pipelines	0.0	0.0	5.8	0.1	0.0	5.7
29	Public administration & defence	6.9	0.9	0.7	7.1	2.4	3.2
30	Education	10.9	1.4	1.2	6.8	0.4	0.3
31	Health & social work	10.6	1.4	1.1	8.8	2.3	0.4
32	Retailing	6.6	0.9	0.5	1.8	0.0	3.0
33	Distribution nes	2.9	0.4	0.2	1.8	0.0	4.8
34	Hotels & catering	5.4	0.7	0.4	2.9	0.0	0.3
35	Other transport services	2.2	0.3	0.2	0.2	0.0	0.6
36	Communications	0.7	0.1	0.1	0.3	0.0	1.4
37	Banking & finance	1.0	0.1	0.1	0.3	0.0	0.4
38	Insurance	1.0	0.1	0.1	0.2	0.0	0.2
39	Computing services	0.7	0.1	0.1	0.2	0.0	0.2
40	Professional services	2.0	0.3	0.2	2.6	0.0	2.5
41	Other business services	2.0	0.3	0.2	0.0	0.0	0.0
42	Agriculture	5.4	0.2	0.7	0.7	0.1	3.8
43	Miscellaneous services	0.0	0.0	0.0	2.4	0.4	2.0
44	Miscellaneous	0.0	0.0	0.0	0.0	0.0	0.0

Note(s) : Each column sums to (approximately) 100%. The figures are therefore shares in the total of the sectors shown. The data are for final energy consumption only, and exclude residential energy consumption.
Source(s) : NI data, this project.UK data: Derived from Environmental Accounts data reported by the ONS for 2005.

Appendix E: Indication of Quality of Data Sources

TABLE E1: QUALITY OF FUEL CONSUMPTION DATA AND CO_2 EMISSION ESTIMATES

Fuel User Group	Fuel			
	Electricity	Gas	Coal	Oils
01 to 04 Power Generation, Energy Transformation and Energy Industry Own Use	Point source emissions and fuel use data has been obtained for each of the Northern Ireland power stations, together with additional figures for electricity generation, distributional and other losses - from the BERR publication Energy Trends December 2006.			
05 to 23 Industrial sub-sectors	Average quality data for all User Groups. Limited data is available on point source emissions and fuel use from the most energy intensive sites that are included under EU ETS, including large dairies, cement kilns, some hospital boilers and industrial boilers on major manufacturing sites. No data has been obtained for sites that operate within Climate Change Agreements. The most significant fuel switching has been represented, but the detailed industry sector breakdowns are subject to error.			
24 to 26 Air, rail & road transport	Good quality data for all User Groups. The estimation methods used in the NAEI utilise NI-specific activity data on vehicle movements and/or fuel use. Some refinements could be made as the methods tend to assume UK-average fleet composition, but the uncertainty of these estimates is still regarded as quite low.			
27 Shipping	Average to poor data quality for this sector, as the BERR UK fuel use estimate is known to be uncertain. The estimates for international shipping are also quite uncertain.			
28 Domestic	Average data quality for this sector. The BERR DUKES data and the Regional Energy Statistics are somewhat uncertain, especially for solid and liquid fuels.		Data on domestic solid fuels use in NI is very inconsistent.	Average quality data for domestic oil use.
29 to 31 Public sector services	Good quality data for all User Groups. The DFPNI data provides detailed "bottom-up" data on fuel use by sub-sector category.			
32 to 41 Commercial sub-sectors	Average data quality for this sector. The DUKES data and the Regional Energy Statistics are somewhat uncertain, notably for solid and liquid fuels.			
42 Agriculture	Only average to poor data quality for this sector. The DUKES data don't compare well with NAEI estimates, which include a very considerable amount of gas oil use in off-road machinery. However, this sector was not a priority for detailed study, so the issue has been identified but not explored further.			

Key

	Good – Point source data available annually.
	Okay – Limited point source data, some good total fuel use data.
	Poor – Insufficient data for robust calculations. No good quality local data.