The GHG Indicator: UNEP Guidelines for Calculating Greenhouse Gas Emissions for Businesses and Non-Commercial Organisations

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"Through the Financial Services Initiatives, UNEP is catalysing action by banks and insurers to identify innovative responses to climate change, including changing investment patterns, with the aim of greater sustainability, energy efficiency and increased use of renewable energy. In this context UNEP welcomes the Insurance Initiative's efforts to develop a GHG Indicator. This has been used as a model by the United Kingdom to create its own national standard. I encourage other governments to do the same."

Klaus Töpfer, Executive Director, UNEP

DEVELOPMENT OF THE INDICATOR

The idea of establishing a standardised methodology for measuring a company's greenhouse gas (GHG) emissions was initiated in May 1997 by National Provident Institution (NPI)[1] Global Care Investments, UK, with the Centre for Environmental Technology, Imperial College, London, UK. Their initial report was published in November 1997 and was circulated for widespread review to accountants, academics, companies, consultants, environmentalists, financial institutions, government agencies and non-governmental organisations, under the auspices of the UNEP Insurers' Initiative. These guidelines are the result of further consultation with similar groups and incorporate the comments and suggestions from the first review process. They are now intended for translation and widespread distribution in collaboration with the European Bank for Reconstruction and Development (EBRD) and others.

There are many inherent difficulties in creating an accounting methodology for GHG emissions of this type and problems in interpretation will inevitably arise. It is therefore up to the user of the guidelines to get the most from them. If users have better information or know better methods, they are encouraged to incorporate them and adapt the guidelines to their specific circumstances, making it clear where and how they have done so.

Partner Organisations

At the national level, the UK's **Department for the Environment, Transport and the Regions** (DETR) has adapted the UNEP indicator to make it more appropriate to UK conditions. The DETR document "*Environmental Reporting – guidelines for company reporting on greenhouse gas emissions*" is widely considered to be a thorough and robust methodology for national reporting. The present guidelines, in turn, use some of the information from the DETR report, where it improves the original UNEP work. The DETR's work is an excellent example of how the UNEP GHG Indicator can be applied by governments to national circumstances.

At the international level, a **World Resources Institute (WRI) / World Business Council for Sustainable Development (WBCSD)** collaboration is aiming to produce a GHG Protocol which companies can apply at three levels: facilities; facilities and internal emissions; and facilities, internal emissions and emissions from other sources. The UNEP indicator is seen as a core part of this third level. Both the DETR and WRI/WBCSD initiatives are highly welcome and widely respected developments in this field.

UNEP is also collaborating with the **International Energy Agency** (IEA), in Paris, which will provide current CO_2 (carbon dioxide) statistics for electricity. This assistance, helping to ensure that the indicator is up to date, is greatly appreciated.

Within Europe, the **European Bank for Reconstruction and Development** (EBRD) has agreed to promote the document as part of its due diligence process for projects in Eastern Europe. This illustrates the usefulness of the indicator and will increase understanding and accountability for carbon emissions in those regions.

At the corporate level UNEP is pleased to announce collaboration with **Blue Circle Industries PLC**, to promote and trial the indicator throughout their international operations. This exercise will help to ensure that the indicator is practicable and applicable world-wide.

Members of the **Global Reporting Initiative (GRI)** will also consider the indicator in their future deliberations.

[1] In 1999, the AMP GROUP acquired NPI. The NPI Global Care research and investment activities were transferred to their global asset management company, Henderson Investors.

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In 1997, Charles Thomas undertook the initial research for this project as part of his MSc in Environmental Technology at the Center for Environmental Technology, Imperial College, London. The research was undertaken with guidance from the NPI Global Care Investments Research Unit. The first report was completed in collaboration with Tessa Tennant, Head of the Unit, in time for the Kyoto meeting in December 1997. In 1998, Charles was sponsored by NPI, and hosted by UNEP Geneva to conduct an extensive peer review of the work, from which a second version of the report was produced. He now works for BP Amoco and continues as an adviser to the project.

Tessa Tennant

Since its inception in 1997 to April 2000, Tessa has been the project supervisor and editor. In May she resigned as Policy Adviser to Henderson Investors Socially Responsible Investment Team, UK. She continues to be involved with the UNEP Finance Initiative.

Jon Rolls

Graduated from Sussex University in 1995. After working for Fina Exploration Ltd. for a short while, he went on to study for an MSc in Environmental Technology at Imperial College. Focusing in particular on Climate Change, he wrote his thesis on the Kyoto Protocol and the oil industry, in collaboration with Total Oil Marine PLC. Jon has updated and revised the guidelines since the last revision and prepared them for final peer review. He is now working as Environmental Engineer at the Thames Barrier, part of the UK Environment Agency.

Finally, the document benefited greatly from the professional editing of Geoffrey Bird.

ABBREVIATIONS

CEF	Carbon Emission Factor
CFC	Chlorofluorocarbon
CH_4	Methane
CHP	Combined Heat and Power
CO_2	Carbon dioxide
CO_2EF	Carbon Dioxide Emission Factor
EBRD	European Bank for Reconstruction and Development
EEA	European Energy Agency
EPA	Environmental Protection Agency
GHG	Greenhouse gas
GWP	Global Warming Potential
HGV	Heavy Goods Vehicle
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IPPC/IPC	Integrated Pollution Prevention Control / Integrated Pollution Control
KWh	Kilowatt Hour
LGV	Light Goods Vehicle
LPG	Liquefied Petroleum Gas
N_2O	Nitrous oxide
NCV	Net Calorific Value
SME	Small and Medium-Sized Enterprise
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WBCSD	World Business Council on Sustainable Development
WRI	World Resources Institute

LIST OF FIGURES AND TABLES

Figure 1: Summary of the Framework of the CO_2 Indicator 12
Figure 2: Sector Shares of Carbon Dioxide Emissions, 1996 15
Table 1: Total electricity consumption growth projections in billions of kilowatt-hours 16
Table 2: Conversion Value References 21
Table 3: Default Carbon Dioxide Emissions from Fuels 23
Table 4: Conversion values for petrol, diesel, and liquefied petroleum gas 25
Table 5: Emission Factors for Vehicles 25
Table 6: Conversion values for different passenger transport modes 25
Table 7: Conversion values for different freight transport modes 26
Table 8: Summary of Global Warming Potentials 27
Table 9: Country Specific Net Calorific Values & Carbon Dioxide Emission factors 43
Table 10: NCV's For Fuels 44
Table 11: CEF's For Fuels 44
Table 12: Electricity Emission Factors for 1990 and 1996 in t CO_2/kWh 47
Table 13: Annex 1 Countries to the Kyoto Protocol and Emission Reduction Requirements 56

CONTENTS

DEVELOPMENT OF THE INDICATOR 4
ACKNOWLEDGEMENTS....5
ABREVIATIONS....6
LIST OF FIGURES AND TABLES....7
CONTENTS....8
1 INTRODUCTION....10
1.1 About the Guidelines 10
1.2 Structure of the Guidelines 11
1.3 How to Use the Guidelines 11
1.4 When the Process is Complete 13
2 THE NEED FOR AN INDICATOR 14
2.1 The Environmental Context 14
2.2 No Management without Measurement 14
2.3 Why are Shareholders Interested? 15
2.4 Industry's contribution to climate change 15
2.4.1 Electricity Consumption....16
2.4.2 Energy Efficiency in Industry 16
2.4.3 Transport-Related Emissions 16
2.5 The State of Climate Change Reporting 16
2.6 Updating the GHG Indicator Guidelines 18
2.7 Conclusion: Summarising the Need for an Indicator 18
3 GETTING STARTED…A GHG INDICATOR FOR COMPANIES 19
3.1 The Basis for Calculating a GHG Indicator 19
3.2 Setting the Boundaries 19
3.2.1 Defining the Boundaries of a Company 19
3.3 Introducing Conversion Factors 20
3.3.1 Scope and Application of Conversion Factors 21
3.4 Carbon Offsets/Sequestration 21
3.5 Energy-Related Greenhouse Gas Emissions 21
3.5.1 Where to Obtain Data for Fuel Combustion and Electricity Consumption 22
3.5.2 Combustion of Fuels 22
3.5.3 Coal-Derived Emissions....22
3.5.4 Combustion of all Fuels 22
3.5.5 Electrical Generation....23
3.5.6 Combined Heat and Power (CHP) 23
3.5.7 Non-Carbon Dioxide Greenhouse Gases from Fuel Combustion 24
3.6 Transport-Related Emissions 24
3.6.1 Where to Obtain Data on Transport Use 24
3.6.2 Road Vehicle Transport....24
3.6.3 Non-Road Transport....25
3.7 Process-Related Emissions 26
3.7.1 Where to Find Data on Process-Related Emissions 26
3.8 Aggregation and Normalisation of the GHG Indicator 27
3.8.1 Turnover....27
3.8.2 Added Value....28
3.8.3 Employees 28
3.8.4 Unit of Production....28
3.8.5 Summary of Normalisation 28
3.8.6 Carbon Dioxide Over Time....28
4 WORKSHEETS FOR THE CALCULATION OF A COMPANY'S GHG IMPACT 29
4.1 CO_2 Emissions from Fuel Use 29
4.2 Electricity Generation 30
4.3 Combined Heat and Power (CHP) 31
4.4 Road Transport 32
4.5 Unit. Kilometre Transport 33
4.6 Process Related Greenhouse Gas Emissions 34
4.7 Total Global Warming Impact in CO_2 Equivalent 35
4.8 Normalising CO_2 Potential 35
4.9 GHG Profile Over Time 36

5 RECOMMENDATIONS 37
6 FURTHER RESEARCH 38
6.1 CONVERSION VALUES 38
6.2 OUTSOURCING/BOUNDARY SETTING 38
6.3 WASTE EMISSIONS 38
6.4 IMPLICATIONS OF THE KYOTO PROTOCOL AGREEMENT 39
6.5 LIFE CYCLE IMPACTS 39
7 BIBLIOGRAPHY 40
8 APPENDIX 43
8.1 EMISSIONS FROM FUEL USE 43
8.1.1 Coal 44
8.1.2 Other Fuel Emissions 44
8.2 ELECTRICITY-DERIVED CARBON DIOXIDE EMISSIONS 45
8.3 COMBINED HEAT AND POWER 48
8.3.1 Do you IMPORT electricity or heat generated by CHP? 48
8.3.2 Do you EXPORT some of the electricity or heat from your CHP? 48
8.3.3 EXPORTING electricity or heat from your CHP 49
8.3.4 IMPORTING electricity or heat generated by CHP 50
8.3.5 Your CHP Uses MORE THAN ONE FUEL 50
8.4 ROAD TRANSPORT 51
8.5 UNIT. KILOMETRE TRANSPORT 52
8.6 PROCESS RELATED SECTORS 53
8.7 CONVERSION TABLES 54
8.8 CORPORATE ENVIRONMENTAL REPORTS SURVEYED FOR ORIGINAL INDICATOR (1997) 55
8.9 ANNEX 1 COUNTRIES TO THE KYOTO PROTOCOL 56
8.10 CARBON OFFSETS/SEQUESTRATION 57
9 CONTACT DETAILS 58
10 USEFUL INFORMATION 59
11 FEEDBACK FORM 60

INTRODUCTION

Climate change resulting from human activities is now recognised as one of the most pressing environmental issues facing the world's population. In addressing this problem, governments, the international community and industry are moving to control emissions of greenhouse gases (GHGs), setting targets such as those agreed at the Kyoto Conference in 1997. These moves will continue in the future and, inevitably, businesses and other organisations will increasingly have to account for and report on GHG emissions.

1.1 About the Guidelines

The purpose of "The GHG Indicator*: UNEP Guidelines for Calculating Greenhouse Gas Emissions for Businesses and Non-Commercial Organisations"* is to assist organisations in this accounting and reporting process. The guidelines provide a methodology whereby GHG emissions are calculated, then combined to give a single-figure GHG Indicator for an organisation's contribution to climate change.

An essential characteristic of the method is that it uses information readily obtainable by companies. This data, expressed in commonly used "basic" units, can be converted and aggregated to calculate the total contribution to climate change. The indicator is applicable at all levels of a company regardless of size, from individual sites to lines of business, to the parent company.

Governments are also encouraged to use the guidelines to develop their own country-specific methodologies, substituting national data for the generic international data provided.

The data and the methodology employed could become an established basis for calculation of GHG indicators for all organisations world-wide.

The guidelines are relevant to both developed and developing countries. Although the quantified reductions in GHG emissions fixed by international agreement apply only to the industrialised nations at present, such reductions may well be required of developing countries in the future. Companies and organisations that are readily able to quantify emissions will find it easier to enter into the Kyoto mechanism and will thus reap the rewards of early action.

The usefulness of the GHG Indicator can be summarised in five ways:

- It is a direct response to the Kyoto agreements.
- It enables countries or companies with little experience to engage in the GHG accounting process, creating a common reporting platform.
- It encourages companies to think and act more environmentally.
- It anticipates measures that might be adopted by governments in response to Kyoto.
- It stimulates early action.

The GHG Indicator also allows for credible and comparable data inventories, which are essential for the implementation of the Kyoto Protocol.[2]

[2] See "The Kyoto Protocol and Beyond: Potential Implications for the Insurance Industry"

1.2 Structure of the Guidelines

The major sections of the guidelines are summarised below:

- Section 1 introduces the indicator and explains how different types of readers may use it.

- Section 2 describes the background of global environmental concerns against which the indicator has been developed, giving a clear explanation of its purpose and usefulness. The indicator is then set in its wider context by an examination of the overall contribution of industry to climate change, and a brief look at the present state of environmental reporting by companies.

- Section 3 explains the methodology on which the indicator is based and takes the reader through the rationale of the approach. This section will be especially useful to companies who do not fully understand why or how their climate change impact arises. For all readers, it provides a thorough preparation for use of the Worksheets in the following section. The important question of defining a company's boundaries, to establish exactly which emissions are to be included, is also discussed.

- Section 4, – the "working" part of the guidelines – provides a step-by-step guide to calculating a final figure for a company's emissions. The section consists of Worksheets and instructions for their use. Reference is made throughout to the document's appendices (Section 8) which provide technical information to support the tasks accomplished with the Worksheets.

- Section 5 gives recommendations for further actions once the process is completed.

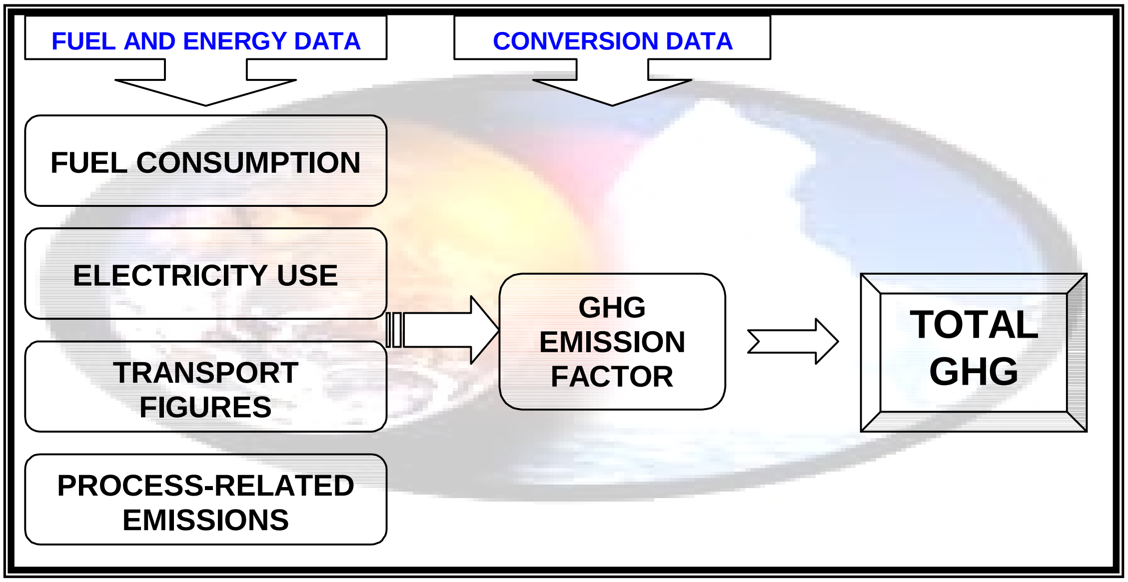
- Section 6 outlines some of the methodological barriers encountered at present and identifies areas where future research must be directed. It is anticipated that feedback will ensure that the indicator constantly evolves and improves in accuracy. Users are invited to take part in this revision process by filling out the feedback form (Section 11) and returning it with their comments, either positive or negative.

Other sections provide additional sources of information and contacts.

1.3 How to Use the Guidelines

The guidelines take a step-by-step approach to deriving the GHG Indicator, making them an ideal starting point for users who lack experience in this area. However, the "working" part of the document – a set of Worksheets with clear instructions for their use – is contained in a single section, allowing experienced users to go straight to the process of calculating emissions. Figure 1 shows the generic framework of the process and the information needed to derive the GHG Indicator.

Figure 1: Summary of the Framework of the GHG Indicator



What to do…

…For a Company

Companies with existing knowledge and experience in implementing this type of indicator may want to skip Sections 2 and 3 and start using the Worksheets in Section 4 directly, referring back when necessary. However, all users are advised to look at Section 3.2, covering reporting boundaries, before proceeding.

Companies with little or no experience should take time to go through the process systematically. It may take time to get some of the information required, but good quality data must be collected before trying to use the Worksheets. The IPCC guidelines on GHG Inventories (Section 10) have useful reference material for further study and form the basis for much of this work.

Users should go through the Worksheets systematically, referring to the Appendices where necessary. Once completed, each Worksheet will give a single number in a box. Total GHG emissions are obtained by simply adding these numbers together. Section 4.3 should be ignored if the company does not use combined power and heat systems (CHP) or import electricity produced by CHP.

…For a Government

Governments may not have fully considered the implications of Kyoto or developed GHG accounting guidelines for companies and organisations within their jurisdiction. These guidelines can help to provide a simple methodology on which to base domestic guidelines for companies. They provide the structure and information needed; all governments have to do is to replace the generic international emission factors and conversion factors with appropriate national data. If Governments are included in Annex 1 of the Kyoto Protocol (see Appendix 8.9) they will already be reporting emissions at a national level and submitting this information to the UNFCCC. This UNFCCC data can be used to create national emission factors.

However, the reporting format used for national submissions is unlikely to be suitable for company reporting. This is where the GHG Indicator can help.

Countries not included in Annex 1, and which therefore do not submit data to the UNFCCC, can still adapt the guidelines for domestic use. Information on electricity emissions and the net calorific value (NCV) of coal should be available. Adopting the GHG Indicator methodology and adapting the guidelines to domestic conditions will assist in setting up domestic reporting systems. This can help companies to understand the impacts arising from their GHG emissions and to begin to reduce them, or at least to know the extent of their future liabilities.

1.4 When the Process is Complete

When the GHG Indicator has been calculated it is important to report findings. Where possible, calculations should go back to 1990 (in line with Kyoto). Whether this is done as an internal exercise or for external stakeholders, it is very important to be open and honest about the assumptions made and boundaries used.

For external communications the results can be reported in a number of ways including:

- An additional section in the company annual report and accounts
- Feeding into existing company environmental or sustainability reports
- Stand-alone reports on climate change and GHG emissions

For more information on environmental/sustainability reporting, see the GRI Guidelines (Section 10). These outline an initiative to standardise company reporting on environmental, social and financial issues, referred to as the 'Triple Bottom Line' approach.

Finally, third-party review of the company's emissions is beneficial, confirming that results are correct and credible. This can be done in the form of an independent verification of statements and data.

2 THE NEED FOR AN INDICATOR

2.1 The Environmental Context

Reporting in 1995, the Intergovernmental Panel on Climate Change's Working Group 1[3] concluded that "*… the balance of evidence suggests that there is a discernible human influence on global climate."*[4] Things have not improved since then. In fact, concerns have increased and it is now widely predicted that increased temperatures would, globally, lead to more severe droughts and/or floods and the possibility of more extreme weather events. Rising sea levels would lead to the displacement of millions of people in low-lying delta areas and some small island states could be wiped out. Agriculture could be affected, with reduced production in areas where food supply is already deficient. Additional health problems may also arise with the ranges of animal species which are vectors for disease (e.g. mosquitoes) being increased. This could lead to vector-borne diseases such as malaria being re-introduced into areas from which they have been eradicated.

In spite of these warnings, global emissions of carbon dioxide (CO_2), the greenhouse gas responsible for most global warming, have increased over the last decade at an average annual rate of 1.3 per cent or nearly 300 million tonnes per year[5].

The process of controlling GHG emissions began when delegates at the 1992 Rio Earth Summit gave international recognition to the problems associated with climate change and signed the United Nations Framework Convention on Climate Change (UNFCCC). Subsequent meetings of the Parties to the Convention concluded that more needed to be done and firm targets were set at the third Conference of the Parties (COP 3), held in Kyoto, Japan, in December 1997. The Kyoto Protocol, which emerged from COP 3, is particularly important because the signatory parties committed for the first time to implementing quantified targets for GHG emission reductions.

2.2 No Management without Measurement

Although the Kyoto Protocol indicates methods that might be used to achieve GHG reductions, it is left to individual countries to decide how they will use those mechanisms and what individual targets they will impose at the domestic or sector level. However, irrespective of the measures that countries choose to introduce, business will be required to play its part in reducing emissions. In this situation, companies will need to be able to measure their impacts if they are to manage them. By providing a pragmatic, precautionary approach to reducing GHG emissions, the GHG Indicator allows companies to meet this need.

Furthermore, managing and reducing energy use and GHG emissions can be a catalyst to improved efficiencies and can pave the way to more environmentally benign energy technologies. Such reduction measures are therefore beneficial to long-term company success in their own right and should be supported by shareholders on their own merits.

Many companies already recognise the importance of energy measures as a key indicator of their production efficiency and environmental impacts. It is now time to move towards a standard way of accounting for GHG emissions that has wide acceptance and can become a routine company reporting requirement world-wide. A standard reporting methodology would

[3] The Intergovernmental Panel on Climate Change (IPCC) is the scientific body, made up of thousands of scientists, that advises the UN Framework Convention on Climate Change (UNFCCC). It is an internationally respected expert panel.
[4] IPCC Working Group 1 Report, 1995, pp. 11-12.
[5] Global Environment Outlook, UNEP 1999, pp 25.

improve market information flows, allow identification of companies with successful emissions reduction programmes and facilitate increased corporate awareness of climate change.

2.3 Why are Shareholders Interested?

The proposal that companies should report on their GHG emissions is not just a matter of corporate responsibility towards an important global issue, it is also a matter of providing shareholders with adequate information about exposure to new costs as well as the advantages which can result from improved environmental performance.

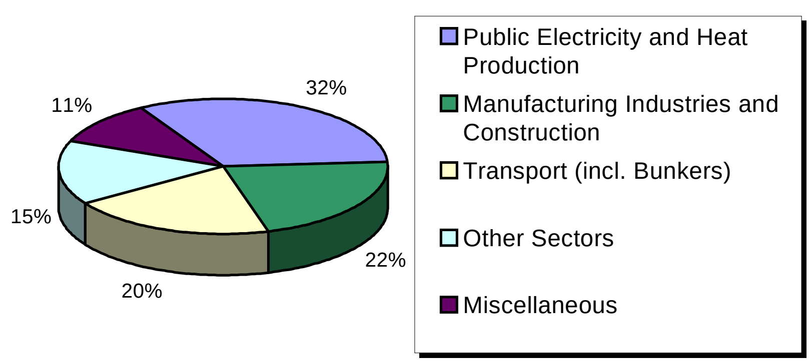
There are fears that costs are likely to arise from taxes and changing market conditions as measures to counter increased global warming are introduced. On the other hand, proof of a positive correlation between better environmental performance and share price would be a compelling reason for companies to invest in environmental improvements. For their part, investors are also beginning to look more carefully at companies' environmental performance (Blumberg et al. 1997). A growing body of work suggests that companies that rate highly on environmental criteria also provide better-than-average returns to shareholders, and that financial analysts and investors can improve their investment performance by analysing environmental value drivers (Hart and Ahuja 1996, Feldman et al., 1996, Cohen et al. 1995, Cordeiro and Sparks 1997).

While these studies are building a case, they do so by assessing a range of environmental issues, not simply measures to abate global warming. A direct correlation between global warming abatement and financial performance has not been made, although it should be noted that companies frequently cite energy saving measures as good for the environment and the bottom line. The IRRC (1994) noted with its emissions efficiency index that it may have identified instances in which firms achieved some competitive advantage. Similarly EFFAS (1994) reported that energy efficiency measures can be regarded as a valuable indicator for the overall efficiency of a company.

2.4 Industry's contribution to climate change

Industry accounts for a substantial proportion of GHG emissions. Emissions arise primarily from electricity and heat production, but also from industrial processes and transport use. In 1996, industry accounted for 22 per cent of CO_2 emissions directly and a major proportion of the further 52 per cent attributed to transport and electricity supply (See Figure 2).

Figure 2: Sector Shares of Carbon Dioxide Emissions, 1996



Source: IEA, 1998

2.4.1 Electricity Consumption

This is the single greatest contributor to the production of greenhouse gases. Emissions clearly depend on the energy mix and efficiency of the generating stations. Despite the increasing efficiency of some industries, projections for OECD and emerging nations show that industrial consumption of electricity is likely to increase overall. Table 1 reveals the scale of the problem.

Table 1: Total electricity consumption growth projections in billions of kilowatt-hours

Region	1995	2000	2005	2010	2015
N. America	3604	3990	4360	4700	5068
Western Europe	2276	2730	3070	3420	3790
Industrialised Asia	1066	1320	1490	1648	1788
Former Communist Block	1530	1575	1744	1920	2070
Developing Asia	1730	2470	3250	4090	5070
S. America	560	680	830	970	1119

(Source: Morgan Grenfell, 1997)

2.4.2 Energy Efficiency in Industry

The manufacturing sectors of industrialised countries grew, on average, at about 2.3 per cent per annum during the 1973-1988 period, while energy use decreased by about 1.2 per cent per annum (Schipper and Meyers, 1992). There is substantial evidence of energy efficiency gains in business. While this trend is encouraging and is expected to continue, the scale of industrialisation world-wide suggests that industry will remain a significant source of CO_2 emissions. It should also be noted that the greatest savings have been in those industries where energy use is a substantial part of the cost of production. Other industries where this is not the case, such as the construction industry, are still highly inefficient even though the ongoing energy costs may be very high.

2.4.3 Transport-Related Emissions

Historically, this source has grown faster than overall economic activity. Increase has occurred because the real prices for transport have fallen, there are more cars on the roads and improvements in fuel efficiency of vehicles have been counteracted by the increase in numbers of kilometres driven (Michaelis, 1996). Vehicle energy consumption accounts for 83 per cent of total transport energy consumption (EEA, 1996).

Transport emissions are of particular importance since growth shows no signs of abating in the near future (EEA, 1996). Various future scenarios indicate that transport energy use may rise by 40-100 per cent in industrialised countries by 2025 (IPCC, 1996b). The increasing industrialisation of developing countries, leading to increases in car usage and ownership, is also a well-documented area of concern. Transport is a vital part of most industrial processes, indeed transport emissions may be the largest contributor to global warming for some service sector industries. Transport emissions must therefore be accounted for in the development of any company-based GHG Indicator.

2.5 The State of Climate Change Reporting

As an initial part of the research for this indicator, a range of environmental reports were studied to assess the scale of company reporting and establish to what extent climate change was incorporated.

Seventy-five corporate environmental reports were surveyed from UK and international companies for the first edition of the indicator. These reports[6] were analysed against a series of criteria to produce quantitative results on the state of global warming reporting. The significant trends from the analysis were:

- ***Climate change was commonly reported as an issue of business concern (77 per cent).***
- ***53 per cent of companies were signatories of industry, national or international environmental charters.***
- ***44 per cent had their environmental information verified externally.***
- ***Energy was the most commonly reported global warming issue (73 per cent) with many companies reporting on typical fuels and amounts of fuels used.***
- ***Transport results highlighted the poor reporting of quantitative data on fuel usage and mileage: between 12 and 24 per cent of companies.***
- ***Process-related emissions, although industry specific, were also poorly reported.***

The measurement of GHG and energy-related emissions is becoming a part of accounting for business.

The principal limitation of current methodologies is the lack of a commonly agreed measurement protocol. Companies and organisations have been developing their own methodologies and the results are therefore idiosyncratic and have a limited use for benchmarking purposes. At best companies and shareholders can only 'guestimate' the success of emissions reductions policies relative to competitors.

The fact that the UNEP GHG Indicator has been adapted by the DETR (UK) and received generous feedback leading to the demand for it to be updated shows that the field of climate change reporting is taking off. Since the publication of the DETR guidelines, approximately 50 companies in the UK and overseas have adopted them and are in the process of reporting on their findings.

The KPMG International Survey of Environmental Reporting[7], 1999, also shows that environmental reporting is on the increase in general. KPMG surveyed the Fortune 250 (top 250 companies in the world) and also the top 100 companies in 11 countries. The latest report shows that reporting increased from 13 per cent in 1993 to 24 per cent in 1999. Although the KPMG survey does not specifically look at climate change reporting, it does break down reporting into topics. Quantitative data on air emissions was reported more than any other topic. 75 per cent of companies surveyed reported quantitative data on their air emissions, up from 64 per cent in 1996.

The overall message from the survey is that reporting is on the increase but there is still much improvement to be made. Heavy industry remains at the forefront of environmental reporting and banks and the financial sectors are lagging behind. The future of reporting lies in the verification of statements and the establishment of a universal approach to reporting.

Section 10 gives some valuable sources of environmental reporting data, including links to the GRI, and other environmental reporting sites.

[6] See Appendix 8.9 for a full list of environmental reports used.
[7] KPMG, 1999, pg. 14

2.6 Updating the GHG Indicator Guidelines

UNEP intends to update these guidelines periodically in collaboration with WRI/WBCSD. The following websites will indicate the latest developments:

- www.unep.ch
- www.ghgprotocol.org

The International Energy Agency has also offered to make electricity emission factors available on a regular basis, setting up a system to extract data relevant to the indicator when required. This will make updating international emission factors relatively easy.

The feedback form in Section 11 will also be used to update and incorporate user feedback.

2.7 Conclusion: Summarising the Need for an Indicator

Reacting to the increasing evidence of human influence on the Earth's climate through emissions of greenhouse gases, governments are increasingly fixing targets for their reduction. Industry, as a major source of greenhouse gases, will inevitably be affected by new emission-reduction requirements and will increasingly need to be able to account for its emissions.

Although measurement of GHG emissions is becoming an accepted part of business accounting practice, and environmental reporting is increasing generally, there is no accepted standard measurement protocol for GHG emissions. Companies and organisations have developed their own methodologies producing results which have limited use for benchmarking purposes. It is therefore difficult for companies and shareholders to accurately assess the success of their emission-reduction policies in relation to those of competitors.

It is clear that companies and other organisations now need a way to assess their own contribution to climate change in terms of GHG emissions, and that – on a wider scale – a standard method is needed to allow comparison of the effectiveness of measures and policies introduced at the organisational, national and international levels. These are the needs which the GHG Indicator addresses. By applying the methodology contained in these guidelines, individual companies and other interested organisations can derive GHG Indicators to quantify climate change impact. By adapting the guidelines to their own specific situations, governments and other institutions can use them to provide a widely accepted and established way of assessing such impacts.

3 GETTING STARTED…A GHG INDICATOR FOR COMPANIES

This section describes the parameters and data requirements of the indicator. It looks at the different sources of GHG emissions and indicates where a company might obtain the data to calculate them. It provides an introduction to calculation of the GHG Indicator and some basic instruction for the Worksheets in the next section used to calculate GHG emissions.

3.1 The Basis for Calculating a GHG Indicator

There are two main contributors to a company's GHG emissions: energy-related emissions and process-related emissions. Together they represent a very high proportion of the global warming contribution of normal business activities. To derive the GHG Indicator, they are assessed and calculated separately, then aggregated. The aggregated GHG value is then normalised using a measure of business activity. Normalisation is essential as it this step which allows inter- and intra-company comparison.

The methodology used to derive the GHG Indicator is based on fundamental research by the IPCC (1996a) for calculating the global warming potential of chemical species. The key to the model is the conversion of all relevant emissions to the IPCC reference gas (carbon dioxide); emissions are also referred to as carbon dioxide equivalents. To date, the IPCC work is the most scientifically and politically acceptable. It also allows for the combination of energy-related emissions and process-related emissions into a single metric.

3.2 Setting the Boundaries

Defining a company's boundary for the purposes of accounting for GHG emissions is notoriously difficult. Every company has a different structure. For instance, it may own or operate different sites; have equity shares in other operations; own subsidiary companies; and out-source varying amounts of business. For these reasons it is very difficult to create a single definition of a company that allows inter-company comparison.

3.2.1 Defining the Boundaries of a Company

In spite of the difficulties involved, use of these guidelines requires some boundaries to be defined if any comparison of final results is to be meaningful. It is, however, accepted that a company using the guidelines will have to make some decisions as to what to include or exclude. These decisions must be made explicit.

> *"Defining the boundaries of responsibility is a difficult matter."*
>
> *Graeme Castles, Business Development Manager, British Salt*

One approach is to set boundaries according to internationally accepted accounting practice[8]. This considers three main tiers of inter-company investment:

- The holding company;
- Where a company owns a controlling interest in a subsidiary (where more than 50 percent of the shares are owned or where control is exercised);
- Any joint arrangement or operations that are proportionally consolidated.

[8] This was the approach used for the first version of the Indicator (November, 1997).

For consolidated accounts, parent companies should require subsidiaries, associate companies and other company investments to follow the same GHG reporting procedures.

Using the above criteria is a useful way to define the boundaries for reporting emissions. However, the limitations of such accounting protocols can be seen when, for example, calculating emissions from travel activities, where it may or may not be possible to evaluate data from a travel agent, or fuel-use data from a fleet hire company. In these situations companies must strike a balance between the effort required to obtain this type of data and the overall impact of the particular activity.

Where companies own stakes in other businesses but are not in day-to-day control they can, as a shareholder of that operation, exert influence to make operators account for GHG emissions. Even if operators do not agree to a full inventory of emissions, they can make data available so that the shareholding company can calculate its equity share of emissions.

This type of structure is common in the oil and gas industry. For example, The BP-Amoco Carbon Dioxide Protocol treats emissions in this way, accounting for the company's share of all operations even where it is not an operator.

In conclusion, a company using the indicator should report on all operations that fall within the following boundaries, using the same GHG procedure for all sites:

- The holding company
- Where a company owns an interest or equity share in a subsidiary, no matter how small
- Any joint arrangement or operations that are proportionally consolidated.

Summary

Boundary setting is extremely difficult and can lead to misinterpretation of results unless it is very explicit. Whatever the company chooses to include or leave out should therefore be stated in an accompanying paragraph or section in any resulting report. The assumptions used in estimating companies' GHG emissions must be made public so that informed comparisons can be made and results properly understood.

> *"The big problem is making sure you are comparing like with like."*
>
> *Julian Salt,*
> *Loss Prevention Council*

3.3 Introducing Conversion Factors

Conversion factors, used to convert all relevant emissions to the IPCC reference gas, carbon dioxide, are critical to the calculation of the GHG Indicator as global warming impacts arise from a range of gaseous emissions. The assumptions underlying conversion factors are of paramount importance for wide acceptance. Extensive research was undertaken to source and calculate conversion factors that are both reasonable and fair. The GHG Indicator uses internationally accepted reporting procedures and conversion factors already being applied at a regional, national or international level by companies and other organisations.

As a result of a decision at the first Conference of the Parties (COP-1)[9], it was stated that the IPCC Guidelines for National Greenhouse Gas Inventories "*should be used by Annex 1 countries in preparing their national communications pursuant to the Convention*". In so far as the methodology is applicable to companies, these guidelines have been applied for calculation of the GHG Indicator.

[9] Decision 4/CP.1, COP 1, Berlin 1995.

The 'References Approach' defined by the IPCC (IPCC, 1996a) was adopted. This predicts the potency of a greenhouse gas based on an activity statistic. It is a simple procedure requiring relatively little data and lending itself to widespread application as it provides a 'common denominator'.

Table 2: Conversion value references

Sources of greenhouse gas emissions	Conversion value references
Static energy related emissions	✓ IPCC ✓ OECD ✓ IEA ✓ DETR
Mobile energy related emissions	✓ INFRAS ✓ IPCC ✓ DETR
Process related emissions	✓ IPCC

In producing an indicator that is applicable internationally, certain assumptions have been made and the guidelines obviously have to use average figures on occasion. It is therefore suggested that users apply national conversion factors where possible. If more accurate values are known, these should be substituted. While every endeavour has been made to ensure accuracy of the conversion values in these guidelines, it is in the nature of such values to alter with time. The indicator will be periodically updated to reflect these changes and this should be borne in mind.

3.3.1 Scope and Application of Conversion Factors

All conversion factors require the input of data expressed in basic units (e.g. tonnes for coal or kilowatt-hours for electricity, etc.). Standardised conversion tables, provided in Appendix 8.7, allow conversion from other units into these basic units.

The conversion factors have been selected to facilitate transboundary application of the indicator, geographically and across different business activities. Where possible, conversion factors have been given for individual countries and activities. Where this was not possible default values have been used.

3.4 Carbon Offsets/Sequestration

Some companies are adopting the idea of offsetting GHG emissions by planting trees in another country or storing CO_2 in some other way. However, there are problems with such solutions and they are not included in these guidelines. Readers interested in the arguments that led the authors to exclude them should refer to Appendix 8.10.

3.5 Energy-Related Greenhouse Gas Emissions

The combustion of fossil fuels is the most significant source of global anthropogenic GHG emissions. At a corporate level, energy-related emissions are often the most significant.

Calculating energy-related GHG emissions encompasses many areas of a company's activities. The calculation can be summarised as follows[10]:

- Direct combustion of fuels (Including both primary and secondary fuels[11]).

[10] Companies involved in the generation of energy (e.g. combined heat and power) should include fuel consumption at this stage. See Appendix 8.3 for further instruction

[11] Primary Fuel — Coal, Natural Gas
Secondary Fuel — Refined Petroleum products

Some methodologies split fuel use into primary and secondary fuels. However, to keep calculations simple, all fuels are combined in these guidelines. Most companies using the indicator will probably treat fuel in a similar way, not distinguishing between primary and secondary fuels, unless using them as part of a process.

3.5.1 Where to Obtain Data for Fuel Combustion and Electricity Consumption

Users may need advice on where to obtain the sort of data they need to calculate their company's GHG impact. The following list indicates sources of information for calculating emissions from fuel use. Accounts or administration departments should have this information; alternatively, it might be held by individual managers.

- ✓ Utility provider
- ✓ Electricity bills
- ✓ Invoices for fuel deliveries
- ✓ Meter readings (estimated from invoices if meter readings are not available)
- ✓ Gas bills
- ✓ Pipeline measurements
- ✓ Energy management software

3.5.2 Combustion of Fuels

To calculate GHG emissions from the combustion of fuels, these guidelines make use of an activity statistic (e.g. annual fuel consumption in tonnes) and an emission factor (tonnes of CO_2 per tonne of fuel combusted). For the purposes of these guidelines, emission factors give values in tonnes of $CO_{2,}$ rather than in kilograms.

3.5.3 Coal-Derived Emissions

Emissions from coal vary according to the net calorific value (NCV) of the fuel. This varies from one type of coal to another and therefore varies from country to country or region to region. Appendix 8.1 gives emission factors for as many countries as possible. If a relevant value is found for a particular country, it should be used. If not, the default value for coal, given in Table 3, should be used.

3.5.4 Combustion of all Fuels

Carbon dioxide emissions from the most frequently used fuels, including coal, are shown below (Table 3). For the full calculation procedure of CO_2 emission factors see Appendix 8.1. Combustion of fuels does not include combustion of mobile fuel sources (from vehicle use etc.), as these are incorporated in the transport calculations. Table 3 gives the emission factors for different fuels that a company might use. The emission factors are given for different units, to aid interpretation. Users should be able to find appropriate fuel consumption data in one of the units below. Once this is done, fuel consumption is multiplied by the appropriate factor. Worksheet 4.1 goes through this process step by step.

Table 3: Default carbon dioxide emissions from fuels

Refined Petroleum Products	tCO_2/ therm	tCO_2/ litre	tCO_2/ KWh	tCO_2/ tonne
COAL (DEFAULT)			0.0003413	1.84
Gasoline		0.00222	0.0002496	3.07
Natural Gas	0.005919		0.0002020	2.93
Gas/ Diesel Oil		0.00268	0.0002667	3.19
Residual Fuel Oil		0.00300	0.0002786	3.08
LPG	0.006654	0.00165	0.0002271	2.95
Jet Kerosene		0.00258	0.0002575	3.17
Shale oil			0.0002218	2.61
Ethane			0.0002641	2.90
Naphtha		0.00224	0.0002905	3.27
Bitumen			0.0002641	3.21
Lubricants		0.00263	0.0003631	2.92
Petroleum Coke			0.0002641	3.09
Refinery Feedstock			0.0002641	3.25
Refinery Gas	0.007041		0.0002403	2.92
Other Oil Products		0.00254	0.0002641	2.92

3.5.5 Electrical Generation

Carbon dioxide emissions derived from the consumption of publicly produced electricity are the single highest source of emissions for many industries. Emission levels from publicly generated electricity are highly dependent on the national energy mix used to produce the electricity. For an additional explanation see Appendix 8.2, which gives a complete list of emission factors for electricity usage by country, calculated using IEA data. If government data on electricity emission factors are available, they should be used.

3.5.6 Combined Heat and Power (CHP)

CHP is becoming an efficient and cost-effective way of producing electricity and heat on site. In some situations benefit can also be gained from exporting excess electricity and heat to local heating schemes or to national grids. There are two ways of dealing with emissions from CHP plants in calculating the GHG Indicator.

A: If all the electricity and heat from CHP is generated and used on site, the method for calculation of emissions from fuel combustion, described in Section 3.5, should be used. The fuel used for CHP should then be included in Worksheet 4.1**.**

B: When electricity or heat is exported for economic or social reasons, the exporting company is not accountable for the associated emissions. Such emissions will be accounted for by the user of the electricity or heat. The emissions corresponding to the amount of electricity or heat exported should be calculated and should then be deducted from the emissions total. A full explanation of how to account for CHP is given in Appendix 8.3.

If electricity or heat from a CHP plant is imported, refer to Appendix 8.3.4.

If more than one fuel is used for CHP, refer to Appendix 8.3.5.

3.5.7 Non-Carbon Dioxide Greenhouse Gases from Fuel Combustion

Non-carbon dioxide greenhouse gases generated by fuel combustion are mainly methane (CH_4) and nitrous oxide (N_2O). Emissions of these gases are difficult to quantify but, according to IPCC, their warming contribution is probably minor compared to that of carbon dioxide (IPCC, 1996a). Rough estimates of CH_4 and N_2O contributions from the combustion of coal, natural gas and oil were calculated to be in the region of 1 per cent. Further research will need to be channelled towards this issue. The GHG Indicator's authors will monitor developments in this area.

3.6 Transport-Related Emissions

Emissions from transport are broken down by transport mode. Based on data that a company might reasonably be expected to collect, these guidelines consider:

- Road Vehicle transport

- Non-Road transport

Transport data should include all transport by the company for official business activities and should cover transportation of goods and company personnel by all transport modes covered below. Transport data for commuting to the work place should not be included in the calculation.

Non-carbon dioxide emissions from transport have not been included for the reasons mentioned in 3.5.7, namely that emissions of gases like N_2O and CH_4 are very difficult to quantify and their effect on climate change is thought to be much less than that of CO_2.

3.6.1 Where to Obtain Data on Transport Use

Transport data are generally much harder to obtain than fuel data because they are not always kept in house and are handled externally. However, as indicated by the list below, there are potential sources for such data. For companies that tend to use one particular travel agent for business travel, the agent should have records of all the bookings made. Car rental companies should keep records of cars hired or leased and their mileage. Company accounts departments should also have records of claims by employees for mileage travelled in their own vehicles.

Potential sources are:

- ✓ Fleet records and invoices
- ✓ Employee mileage calculations/claims
- ✓ Information from car rental firms
- ✓ Tax returns from declarations and fleet monitoring records
- ✓ Travel agency invoices and records
- ✓ Freight handler invoices
- ✓ Company vehicle log books

3.6.2 Road Vehicle Transport

Calculating road vehicle emissions is complex, primarily because any one company may use many modes of transport. For the purposes of the GHG Indicator, road vehicle transport is defined as the personnel and freight transport carried out by a company. It should be calculated using total fuel consumption. This avoids the need for data on the different types of vehicles (cars, LGVs or HGVs) and on the mileage for each category. Since emission levels and fuel consumption tend to vary in parallel – e.g. vehicles with high emission rates also tend to have high fuel consumption and vice-versa (IPCC, 1996a) – calculation based on total fuel consumption was selected. Carbon dioxide emissions were then calculated using default conversion rates[12]. Emissions from the consumption of three major transport fuels were calculated and are presented in Table 4.

Table 4: CO_2 emissions (in tCO_2/litre) for petrol, diesel, and liquefied petroleum gas

Fuel type	CO_2 emissions/ fuel type (tCO_2/litre)
Petrol	0.00222
Diesel	0.00268
LPG	0.00165

Source: DETR, 1999

See Appendix 8.4 for more details

Companies frequently rent transport for employees. As this can make a significant contribution to total transport, it is included here. The nature of rented transport makes it difficult to calculate the consumption of specific fuel types. Vehicle kilometre calculations are therefore applied in this instance (Table 5). For more comprehensive calculations see Appendix 8.5.

Table 5: Emission factors for vehicles

Transport	CO_2 Emission Factor	
	tCO_2/kilometre	tCO_2/mile
Average Petrol Car[13]	0.000185	0.000299
Average Diesel Car	0.000156	0.000251
HGV	0.000782	0.00126

Source: INFRAS, 1999

3.6.3 Non-Road Transport

Non-road transport requires a different calculation method because of the difficulties in directly attributing a quantitative measure of fuel consumed. For example, it is difficult to determine the amount of fuel used for an individual employee taking an airline flight. An alternative method is to calculate the emissions per transport mode per kilometre. Data from INFRAS (INFRAS, 1995) were used, based on the group's considerable experience and its data for many transport modes. Data were also provided by the DETR which has undertaken extensive research into emissions from air travel. The emission values (given in Tables 6 and 7) are based on European conditions, provided by INFRAS and the DETR.

Table 6: Emission factors for different passenger transport modes

Transport Mode	Basis	Emission factor for carbon dioxide (tCO_2/ P.km)
Air- short haul[14]	Person.kilometre	0.00018
Air- long haul[15]	Person.kilometre	0.00011
Train[16]	Person.kilometre	0.000034

(INFRAS, 1995;DETR, 1999)

[12] Values were calculated using default IPCC values as previous.
[13] Based on INFRAS data, refer to Appendix 8.5
[14] Average distance of 500 km.
[15] Average distance of 6495 km.
[16] Average length of train 9.8 wagons with occupancy of 31%.

Table 7: Emission factors for different freight transport modes

Transport Mode	Basis	Emission factor for carbon dioxide (tCO_2/ T.km)
Air Freight Short haul[17]	Tonne.kilometre	0.000158
Air Freight Long haul[18]	Tonne.kilometre	0.000570
Train Freight[19]	Tonne.kilometre	0.000047
Inland shipping[20]	Tonne.kilometre	0.000035
Marine shipping[21]	Tonne.kilometre	0.000010

(INFRAS, 1995, DETR, 1999)

3.7 Process-Related Emissions

Process-related emissions are those greenhouse gases emitted from non-energy-related sources. Their main sources are industrial production processes that transform materials chemically or physically. Industrial processes can result in the generation of a wide variety of greenhouse gases. Common industrial processes that result in the production of greenhouse gases have been assessed and default emission values have been calculated by the IPCC. A summary of industrial sectors most involved in process-related greenhouse GHG emissions is provided in Appendix 8.6.

Emissions from industrial processes are estimated as the potential emissions of greenhouse gases produced by a company that it is assumed will eventually be emitted to the atmosphere over a period of time. Production of process-related greenhouse gases must be reported in tonnes and converted to carbon dioxide equivalents. This is done using the global warming potential (GWP) for a 100-year time horizon[22] as a conversion factor. These values are given in Table 8.

3.7.1 Where to Find Data on Process-Related Emissions

- ✓ In European countries, companies may already be measuring their emissions from specific processes under the EU IPPC Directive or national regulations, or may be setting up the infrastructure to do so.
- ✓ Countries outside the EU may have similar regulations governing prescribed processes and sites that require emissions monitoring.
- ✓ National Environmental Protection Agencies or similar institutions may also have records.

[17] Average distance of 457 km
[18] Average distance of 6342 km
[19] Average length of 27 wagons with 49% capacity.
[20] Average tonnage capacity of ~2500 tonnes.
[21] Average tonnage capacity of 51500 tonnes
[22] The IPCC publish conversion values for chemical species in three separate time horizons (20, 100 and 500 years). It was decided that a time horizon of 100 years was most suitable for the indicator. This decision was based on indicators already using or applying IPCC GWP data, such as ETSU (1995), ICI (1997) and Dobes (1995), and based on the requirements of the Kyoto Protocol which stipulates that the 100-year time horizon should be used.

Table 8: Summary of global warming potentials (GWP)

Trace Gas	GWP	Trace Gas	GWP
Carbon Dioxide	1	HFC-143a	3800
CCl 4	1300	HFC-152a	140
CFC- 11	3400	HFC-227ea	2900
CFC-113	4500	HFC-23	9800
CFC-116	>6200	HFC-236fa	6300
CFC-12	7100	HFC-245ca	560
CFC-l 14	7000	HFC-32	650
CFC-l 15	7000	HFC-41	150
Chloroform	4	HFC-43-lOmee	1,300
HCFC- 123	90	Methane	21
HCFC- 124	430	Methylenechloride	9
HCFC-141b	580	Nitrous Oxide	310
HCFC-142b	1600	Perfluorobutane	7000
HCFC-22	1600	Perfluorocyclobutane	8700
HFC- 125	2800	Perfluoroethane	9200
HFC-134	1,000	Sulphur hexafluoride	23900
HFC-134a	1300	Trifluoroiodomethane	<1
HFC-143	300		

Source: IPCC 1990 & 1996

3.8 Aggregation and Normalisation of the GHG Indicator

The most common form of normalised measure is one that relates an environmental measure (e.g. aggregated emissions, energy use) to a measure of business activity (e.g. production, value added or turnover) (James and Bennett 1994). Normalised measures are critical in the production of environmental indicators since they screen out noise from factors such as changing levels of output and focus on the critical relationships (James and Bennett 1994). They also allow industry comparisons to be made.

A study by Belmanesh, Roque & Allen (1993) compared the ranking of American Standard Industrial Classification (SIC) sectors according to different denominators, ranging from value added to number of employees. The results suggested that, although in most cases normalisation does not change the overall performance ranking of industries, in some cases performance varies greatly depending on the normalisation factor used. The study concluded that it was not possible to compare performance using a single normalisation measure. This seems to indicate that each industry sector has its own peculiarities and that normalisation measures must be sector-sensitive.

Aggregation involves the summation of the energy- and transport-related carbon dioxide emissions with the process-related CO_2 equivalent emissions. In the case of the indicator this is straightforward because carbon dioxide equivalents are used throughout and simple addition of totals in the Worksheets gives the aggregated figure.

For normalisation, four denominators were selected as being appropriate for measuring company activity with regard to GHG emissions: turnover, added value, employees, and unit of production.

3.8.1 Turnover

Turnover (also referred to as sales) represents the total value of goods and services sold by the company to third parties in the normal course of trade. Turnover as a denominator is a summation of the whole value of a product or a service up to the point of sale. Unit turnover has the advantage of being an obligatory requirement for annual accounts. Thus, for widespread application by companies, unit turnover is an attractive denominator. However, turnover does not permit inter-sector benchmarking because it does not directly correlate to global warming contribution. On the other hand, turnover may allow intra-sector comparison of companies with similar profiles and production processes.

3.8.2 Added Value

In the 1970's, some companies produced statements focusing on value added for a given period, i.e. sales value minus the costs of bought-in goods and services, including those relating to administrative overheads. These statements showed how much of the added value was distributed to employees as salaries etc., how much to the community via taxes, how much to the providers of capital, and how much was needed to be retained in the business for maintenance or expansion. Value added was considered more socially orientated and was proposed in contrast to profit. The problem with using added value statements as a basis for normalisation is that there are no accepted accounting practices. However, some companies have recently applied a version of this type of added value calculation.

3.8.3 Employees

An Employee denominator is quite simply the number of employees under contract and directly employed by a company. The number of employees is included as a denominator because of its current use and also its applicability to industry sectors in which added value and unit turnover have limited value (e.g. the banking sector).

3.8.4 Unit of Production

Finally, a product, or unit of production, denominator can be used for manufacturing companies. The ability to relate GHG emissions to product output can aid comparison between similar sectors of manufacturing. For example, energy-related CO_2 emissions become part of the 'overheads' associated with a unit of output and can be seen as having a direct influence on the bottom line.

3.8.5 Summary of Normalisation

Research has confirmed the complexity of normalising data satisfactorily. A normalising denominator should be flexible and widely applicable. In the light of these characteristics no single normalising value of unit turnover was chosen for these guidelines, since all the proposed denominators are easily applicable and have relevance to different target audiences. All the normalising values must be calculated under the same framework for consolidation as the GHG data.

3.8.6 Carbon Dioxide Over Time

Along with the normalising factors above, perhaps the best measure of performance is measuring GHG emissions over time. This simple approach allows a comparison to be made year by year and a profile to be created. Worksheet 4.9 shows this in more detail.

4 WORKSHEETS FOR THE CALCULATION OF A COMPANY'S GHG IMPACT

IF YOU CAN'T FIND THE RIGHT UNITS, SECTION 8.7 HAS CONVERSION TABLES THAT MIGHT HELP

4.1 CO_2 Emissions from Fuel Use

Fuel Types	→	Basic unit ❶				X	Emission factors ❷				=	Amount of carbon dioxide released (t) ❸
		Therms	Litres	KWh	Tonnes		tCO_2/ therm	tCO_2/ litre	tCO_2/ kWh	tCO_2/ Tonne		
Coal	→					→			0.0003413	**1.84**[23]	=	
Petrol	→					→		0.00222	0.0002496	3.07	=	
Natural Gas	→					→	0.005919		0.0002020	2.93	=	
Gas/ Diesel Oil	→					→		0.00268	0.0002667	3.19	=	
Residual Fuel Oil	→					→		0.00300	0.0002786	3.08	=	
LPG	→					→	0.006654	0.00165	0.0002271	2.95	=	
Jet Kerosene	→					→		0.00258	0.0002575	3.17	=	
Shale oil	→					→			0.0002218	2.61	=	
Ethane	→					→			0.0002641	2.90	=	
Naphtha	→					→		0.00224	0.0002905	3.27	=	
Bitumen	→					→			0.0002641	3.21	=	
Lubricants	→					→		0.00263	0.0003631	2.92	=	
Petroleum Coke	→					→			0.0002641	3.09	=	
Refinery Feedstock	→					→			0.0002641	3.25	=	
Refinery Gas	→					→	0.007041		0.0002403	2.92	=	
Other Oil Products	→					→		0.00254	0.0002641	2.92	=	
Total	→					→					=	

Step 1:

Enter your fuel use for each fuel in the units you have available in Column 1.

Step 2:

Multiply the figures in Column 1 by the appropriate emission factor in Column 2.

Step 3:

Enter each total in Column 3.

Step 4:

Add up the totals in Column 3 and enter at the bottom of column.

[23] **Refer to Appendix 8 for specific country emission factors for coal. The default value above should only be used if your country is not listed.**

4.2 Electricity Generation

Do not include electricity your company has generated from CHP: this is incorporated in Worksheet 4.3.

If you import electricity that is produced by a public CHP scheme, use this Worksheet.

Country	→	Basic units (kWh) ❶	X	CO_2 EF (tCO_2/kWh) ❷	=	Total CO_2 From Electricity Use (tCO_2) ❸
	→		X		=	
	→		X		=	
	→		X		=	

Step 1

Enter the amount of electricity used (in kWh) in Column 1. If you are calculating CO_2 for more than one country, use the available rows.

Step 2

Find your country in Table 12, Appendix 8.2 and insert the relevant CO_2 Emission factor for your Country in Column 2.

Step 3

Multiply Column 1 by Column 2 and insert the total in Column 3. This is your total for CO_2 from electricity.

4.3 Combined Heat and Power (CHP)

If you import, export or produce your own electricity or heat from CHP, use the appropriate calculation methods from Appendix 8.3 and then enter the totals in the boxes below.

N.B. You will have only one figure in this table unless you are calculating an indicator for multiple sites.

CO_2 FROM IMPORTED CHP ❶	CO_2 FROM OWN USE MINUS EXPORTED CO_2 ❷	CO_2 FROM OWN USE OF CHP ❸

4.4 Road Transport

Fuel type		Basic units (litres) ❶	X	Total CO_2 emissions/ fuel type (tCO_2/litre) ❷	=	Amount of carbon dioxide released (t) ❸
Petrol	➔		➔	0.00222	➔	
Diesel	➔		➔	0.00268	➔	
LPG	➔		➔	0.00165	➔	
Total						

Step 1:
Enter fuel use (in litres) in Column 1.

Step 2:
Multiply Column 1 entries by Column 2 conversion factors.

Step 3:
Enter total in Column 3. Add up all totals in Column 3 and enter at bottom of Column 3.

4.5 Unit. Kilometre Transport

Transport Mode		Units	Basic Units (P.km[24] or T.km[25]) ❶	Basic Units (P.mile[26] or T.mile[27]) ❷	X	CO_2EF (tCO_2/ km) ❸	CO_2EF (tCO_2/ mile) ❹	=	Amount of carbon dioxide released (t) ❺
Car	Petrol	Km/mile			X	0.000185	0.000299	=	
	Diesel	Km/mile			X	0.000156	0.000251	=	
HGV		Km/mile			X	0.000782	0.00126	=	
Air- short haul		P.km/mile			X	0.00018	0.000290	=	
Air- long haul		P.km/mile			X	0.00011	0.000177	=	
Train		t.km/mile			X	0.000034	0.000055	=	
Air Freight	Short	t.km/mile			X	0.00158	0.00254	=	
	Long	t.km/mile			X	0.00057	0.000917	=	
Train Freight		t.km/mile			X	0.000047	0.000757	=	
Inland shipping		P.km/mile			X	0.000035	0.000056	=	
Marine shipping		P.km/mile			X	0.000010	0.000016	=	
Total					X			=	

Step 1:
Enter person/tonnage km in Column 1 or miles in Column 2.

Step 2:
Multiply Column 1 or Column 2 by appropriate conversion factor in Column 3 or 4.

Step 3:
Enter total in Column 5. Add up all figures in Column 5 and enter at bottom of Column.

[24] Passenger.kilometre
[25] Tonne.kilometre
[26] Passenger. mile
[27] Tonne. mile

4.6 Process Related Greenhouse Gas Emissions

Trace Gas	→	BASIC UNIT (T) ❶	X	Conversion Values (GWP, 100 year horizon) ❷	=	CO_2 equivalents (t) ❸
Carbon dioxide	→		X	1		
CCl 4	→		X	1300	=	
CFC- 11	→		X	3400	=	
CFC-113	→		X	4500	=	
CFC-116	→		X	>6200	=	
CFC-12	→		X	7100	=	
CFC-l 14	→		X	7000	=	
CFC-l 15	→		X	7000	=	
Chloroform	→		X	4	=	
HCFC- 123	→		X	90	=	
HCFC- 124	→		X	430	=	
HCFC-141b	→		X	580	=	
HCFC-142b	→		X	1600	=	
HCFC-22	→		X	1600	=	
HFC- 125	→		X	2800	=	
HFC-134	→		X	1,000	=	
HFC-134a	→		X	1300	=	
HFC-143	→		X	300	=	
HFC-143a	→		X	3800	=	
HFC-152a	→		X	140	=	
HFC-227ea	→		X	2900	=	
HFC-23	→		X	9800	=	
HFC-236fa	→		X	6300	=	
HFC-245ca	→		X	560	=	
HFC-32	→		X	650	=	
HFC-41	→		X	150	=	
HFC-43-lOmee	→		X	1,300	=	
Methane	→		X	21	=	
Methylenechloride	→		X	9	=	
Nitrous oxide	→		X	310	=	
Perfluorobutane	→		X	7000	=	
Perfluorocyclobutane	→		X	8700	=	
Perfluoroethane	→		X	9200	=	
Sulphur hexafluoride	→		X	23900	=	
Trifluoroiodomethane	→		X	<1	=	
Total	→		X		=	

Step 1:
Check the table in Appendix 8.6 to see if you are likely to have process-related emissions, although this should be known.

Step 2:
Enter emissions (in tonnes) in Column 1. (Do not include the CO_2 that you have been calculating for the Indicator.)

Step 3:
Multiply Column 1 by Column 2 GWP's.

Step 4:
Enter the results in Column 3. Add up Column 3 and enter the total at the bottom of the Column.

4.7 Total Global Warming Impact in CO_2 Equivalent

Worksheet	GHG Source	Tonnes of CO_2 Equivalent
4.1	Fuel Combustion	
4.2	Electricity	
4.3	CHP	
4.4	Road Transport	
4.5	Unit. Kilometre Transport	
4.6	Process-Related GHG Emissions	
	Total CO_2	

Step 1:

Insert the relevant totals of CO_2 from the previous worksheets for each category. Use only the figures in the green boxes.

Step 2:

Add the column and insert the total in the box at the bottom.

4.8 Normalising CO_2 Potential

Normalising Factor	Group Consolidated Company Figures ❶	Normalised CO_2 Equivalents (tonnes per normalising factor) ❷
Turnover		
Added Value		
Employees		
Unit Production		

Step 1:

From your group company accounts, insert the relevant figures for the four normalising factors in Column 1.

Step 2:

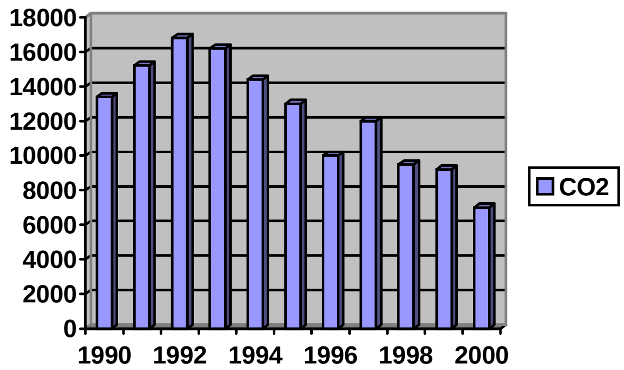
Divide the Total CO_2 in 4.7 above by the Column 1 figures and insert the answer in Column 2.

Step 3:

Use the answers in Column 2 as a ratio for the amount of CO_2 produced for each of the normalising factors, e.g. 45 tonnes of CO_2 for every $ of turnover or 5 tonnes of CO_2 for every car manufactured.

4.9 GHG Profile Over Time

Year	Tonnes of CO_2 Equivalent	% Change
1990		
1991		
1992		
1993		
1994		
1995		
1996		
1997		
1998		
1999		
2000		



Step 1

Insert totals for CO_2 for every year you have calculated in the first column.

Step 2

You can then work out the percentage change between years and insert it in the second column.

Step 3

Using a suitable spreadsheet programme, create a graph similar to that above using the data from the table above.

5 RECOMMENDATIONS

When you have worked through the calculations and derived the GHG Indicator, certain actions are recommended to ensure that the company benefits fully from the exercise. These are listed in the table below.

INDICATOR ISSUES AND CONCLUSIONS	⇨	WHAT NOW
GHG The GHG Indicator gives a single value for emissions for the current year and should be calculated as far back (to 1990) as possible. These figures should be normalised.	⇨	There are ways to present the results of findings: ➢ Annual Report ➢ Sustainability Report ➢ Environmental Report ➢ Climate Change Report ➢ In-house report An in house report would be the bottom rung of accountability and a sustainability report on environmental, social and business issues would be at the top.
Boundaries The limits placed on the reporting framework for the Indicator: are outsourced activities included? What level of transport has been included? Are subsidiaries and so on included? ***Assumptions*** The assumptions made when using the indicator Worksheets. Were users' own conversion or emission factors used?	⇨	Along with the reporting medium chosen, there needs to be a statement of the boundaries and assumptions used for the indicator. There needs to be a clear description of what has been included and left out. This is probably the most important part of the reporting format because it enables informed comparisons to be made and allows the framework of results to be understood. If results are to be transparent and verifiable, the boundaries and assumptions made must be disclosed.
Acting on findings The calculation process may indicate areas where emissions are high or efficiencies are low.	⇨	Action must now be taken to reduce emissions and increase efficiency. Increasing efficiency on site and in processes is probably the first way of reducing emissions. After that, looking into the Kyoto mechanisms, CDM, JI and Emissions Trading, may be considered.

6 FURTHER RESEARCH

The GHG Indicator methodology in these guidelines provides a solid and practical starting point. However, further research is required to improve accuracy and usefulness of the indicator. There are some issues that the guidelines might have included but where current knowledge is limited; inclusion would have diverted the guidelines from their original aim of providing a simple methodology. This is where other initiatives like the WRI/WBCSD approach and the DETR document will play their part and can be used in conjunction with these guidelines.

Some of the issues that warrant further research are discussed below.

6.1 Conversion Values

Research on GHG emissions may give rise to new conversion values that are more appropriate for the indicator. Particular attention should be given to the fuel mixes used in electricity generation. These are continually shifting within countries as a result of government policies and fluctuation in fuel prices. Shifts in conversion values are expected to occur and must be accounted for. Emissions from transport are also unique to domestic conditions. More research is therefore required at the domestic level to produce reliable figures for emissions from transport.

6.2 Outsourcing/Boundary Setting

In the case of outsourcing, significant discrepancies can arise because the global warming impacts of the outsourced activity will not be accounted for, whereas the financial costs and benefits will be included in the consolidated accounts. Until clearer rules are established, companies have a duty to indicate the extent of outsourced activities and should include as many of their operations as possible.

6.3 Waste Emissions

The generation of waste by companies can lead to the production of highly potent greenhouse gases (CO_2 and in particular methane (CH_4)). Disposal and treatment of waste is possible through landfilling, recycling and incineration of solid wastes. Liquid wastes are mainly disposed of through wastewater treatment. The major reasons why waste has not been included in this indicator are the complexity of the question and the potential for error arising from attempts to create simple default values. Further research into the potential global warming contribution from waste would make the indicator more accurate, especially for industries noted for high levels of organic waste such as food production industries and industries involved in pulp and paper, and starch and textile manufacturing.

CH_4 is recognised as the most important greenhouse gas produced through waste. Approximately 5-20 per cent (IPCC, 1992) of global annual anthropogenic CH_4 is released into the atmosphere. The major sources of release are landfilling and wastewater treatment.

Reporting on greenhouse gas emissions derived from waste requires companies to obtain good knowledge of their major waste streams. In particular, companies would have to know the type and amount of wastes produced (in particular the carbon content of the waste) and the disposal methods employed.

Companies should actively seek to quantify their waste now, in preparation for more reliable data on emissions from waste, which can then be incorporated. Anticipating the move to account for emissions from waste will save work in the future.

The DETR is currently working on a guide for businesses on their waste emissions. The DETR has also released a software programme entitled 'WIZARD' which can help you through the waste management process.

To summarise, inclusion of waste emissions in the GHG indicator was made non-compulsory for the following reasons (IPCC, 1996):

1. Landfilling or solid waste disposal:
   - waste disposal practices vary substantially between countries, even down to specific site operators;
   - the composition of industrial wastes varies considerably industry by industry, and company by company;
   - physical factors, such as moisture, pH and nutrients all play significant roles in methane production.
2. Wastewater handling:
   - the organic content of wastewater may vary considerably;
   - wastewater treatment systems determine the level of aerobic conditions;
   - temperature and other factors influence methane production.

6.4 Implications of the Kyoto Protocol Agreement

Articles 6, 12 and 16, of the Kyoto Protocol, corresponding to Joint Implementation (JI), Clean Development Mechanisms (CDM) and Emissions Trading, are all significant for a GHG Indicator. The mechanisms of the protocol represent an opportunity for companies to reduce their greenhouse gases at least cost and where it is most efficient to do so. An accurate baseline estimate of emissions is therefore needed. The UNEP GHG Indicator can provide this initial estimate. It is then possible for a company to assess whether entering into one of the mechanisms of the protocol would be beneficial or not.

Once this decision is made, inventories of emissions would have to be made more accurate for participation in the mechanisms, and the next rung of the 'GHG Indicator' ladder would have to be climbed, i.e. the WRI/WBCSD initiative.

6.5 Life Cycle Impacts

The indicator is not currently designed to measure the global warming impacts of products during their life cycle. Such impacts lie outside existing norms for consolidated group accounts. However, product life-cycle global warming impacts may be very considerable, as in the case of the automobile industry. Further research is required to examine how this might reasonably be reflected in an indicator. If a company has sufficient resources, life-cycle impacts should be considered, as this area of research is likely to become more and more important as experience and knowledge grow. This is particularly relevant as emphasis is increasingly moving away from traditional end-of-pipe solutions to reducing impacts at all stages of the process.

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8 APPENDIX

8.1 Emissions from Fuel Use

Table 9: Country-specific net calorific values (NCV) for coal & carbon dioxide emission factors (CO_2EF)

COUNTRY	NCV TJ/kilotonne	CO_2EF (tonnes of CO_2 /tonne of coal used)	COUNTRY	NCV TJ/kilotonne	CO_2EF (tonnes of CO_2 /tonne of coal used)
Albania	18.284	**1.70**	Kuwait	17.710	**1.65**
Algeria	19.176	**1.78**	Kyrgyzstan	18.673	**1.73**
Argentina	17.585	**1.63**	Latvia	20.306	**1.89**
Armenia	18.673	**1.73**	Lebanon	18.003	**1.67**
Australia	21.227	**1.97**	Libya	17.710	**1.65**
Austria	22.944	**2.13**	Lithuania	17.208	**1.60**
Azerbaijan	18.673	**1.73**	Luxembourg	24.493	**2.28**
Bahrain	17.710	**1.65**	Malaysia	19.427	**1.80**
Bangladesh	16.329	**1.52**	Mexico	21.353	**1.98**
Belarus	18.945	**1.76**	Moldova	18.673	**1.73**
Belgium	24.995	**2.32**	Morocco	18.631	**1.73**
Bolivia	17.710	**1.65**	Nepal	17.543	**1.63**
Bosnia and Herzegovina	20.334	**1.89**	Netherlands	24.702	**2.29**
Brazil	25.874	**2.40**	New Zealand	23.781	**2.21**
Brunei	17.710	**1.65**	Norway	28.303	**2.63**
Bulgaria	18.663	**1.73**	Pakistan	15.701	**1.46**
Canada	22.944	**2.13**	Paraguay	17.710	**1.65**
Chile	21.143	**1.96**	Peru	23.572	**2.19**
China	16.370	**1.52**	Poland	0.000	**0.00**
Colombia	17.124	**1.59**	Portugal	25.581	**2.38**
Croatia	20.464	**1.90**	Romania	13.188	**1.23**
Cuba	17.710	**1.65**	Russia	18.673	**1.73**
Czech Republic	20.222	**1.88**	Singapore	13.105	**1.22**
Denmark	24.283	**2.26**	Slovak Republic	20.071	**1.86**
Ecuador	19.176	**1.78**	South Africa	19.739	**1.83**
Egypt	17.710	**1.65**	South Korea	19.176	**1.78**
Estonia	15.910	**1.48**	Spain	20.934	**1.94**
Finland	23.069	**2.14**	Sri Lanka	17.710	**1.65**
France	26.544	**2.47**	Sweden	23.404	**2.17**
FYROM	20.334	**1.89**	Switzerland	26.084	**2.42**
Georgia	18.673	**1.73**	Syria	17.710	**1.65**
Germany	23.739	**2.21**	Tajikistan	18.673	**1.73**
Greece	19.301	**1.79**	Thailand	19.887	**1.85**
Hungary	19.301	**1.79**	Tunisia	17.710	**1.65**
Iceland	27.591	**2.56**	Turkey	22.232	**2.07**
India	16.454	**1.53**	Turkmenistan	18.673	**1.73**
Iran	17.710	**1.65**	UK	27.005	**2.51**
Iraq	17.710	**1.65**	Ukraine	19.427	**1.80**
Ireland	24.367	**2.26**	United Arab Emirates	17.710	**1.65**
Israel	17.250	**1.60**	Uruguay	17.710	**1.65**
Italy	24.283	**2.26**	USA	23.530	**2.19**
Japan	27.758	**2.58**	Uzbekistan	18.673	**1.73**
Jordan	17.710	**1.65**	Venezuela	17.710	**1.65**
Kazakhstan	18.673	**1.73**	**Default**	**19.841**	**1.84**

Source: OECD/IEA, 1997-1998. Energy Statistics And Balances of Non-OECD and OECD Countries

8.1.1 Coal

If a company knows the specific net calorific value (NCV) of the coal that it uses, then that value should be used in calculating the GHG Indicator. If the NCV is not known, the default country values in Table 9 can be used. These data are taken from IEA statistics and an average is calculated taking the known NCV's for each type of coal produced, imported or exported in a country. The NCV's given by the IEA were originally expressed in tonnes of oil equivalent, in the table they have been converted to terajoules per kilotonne (TJ/kilotonne) to be consistent with the IPCC approach. For the purposes of this methodology the definition of coal covers: bituminous coal and anthracite, sub-bituminous coal, coking coal, lignite, peat, and coal products including, patent fuel, coke oven coke, gas coke and BKB.

An average carbon-emission factor of 25.85 tonnes of carbon/terajoule (tC/TJ) is derived from IPCC 1996a, and applied to country-specific NCV's to give a carbon dioxide emission factor (CO_2EF) for each country listed.

8.1.2 Other Fuel Emissions

Tables 10 and 11 represent the standard IPCC Net Calorific Values and Carbon Emission Factors given in IPCC, 1996a. To arrive at a CO_2 Emission Factor, the carbon values in Table 11 are multiplied by 3.667, as given by the IPCC.

Table 10: Selected net calorific values for fuels

Fuels	NCV (TJ/ kilotonne)
Gasoline	44.80
Natural Gas	52.30
Gas/ Diesel Oil	43.33
Residual Fuel Oil	40.19
LPG	47.31
Jet Kerosene	44.59
Shale oil	36.00
Ethane	47.49
Naphtha	45.01
Bitumen	40.19
Lubricants	40.19
Petroleum Coke	31.00
Refinery Feedstock	44.80
Refinery Gas	48.15
Other Oil Products	40.19

Source: IPCC, 1996a

Table 11: Carbon emission factors for fuels

Fuels	Carbon Emission Factor (tC/TJ)
Gasoline	18.9
Natural Gas	15.3
Gas/ Diesel Oil	20.2
Residual Fuel Oil	21.1
LPG	17.2
Jet Kerosene	19.5
Ethane	16.8
Naphtha	20.0
Bitumen	22.0
Lubricants	20.0
Petroleum Coke	27.5
Refinery Feedstock	20.0
Shale oil	20.0

Refinery Gas	18.2
Other Oil Products	20.0

Source: IPCC (1996a)

8.2 Electricity-Derived Carbon Dioxide Emissions

CO_2 emissions from electricity supply have been calculated using International Energy Agency (IEA) data compiled from IEA publications, *Energy Statistics of OECD Countries, Energy Balances of OECD Countries* and *Energy Statistics and Balances of Non-OECD Countries*, IEA/OECD Paris, 1999. CO_2 emissions come from *CO_2 Emissions From Fuel Combustion 1971-1996.*

IEA CO_2 estimates use the IPCC 1996a reference approach to calculating CO_2. The estimates vary slightly from the National Communications: *"A recent comparison of the IEA estimates with the National Communications showed that for most Annex 1 countries, the two calculations were within 5%." (IEA, 1998, pg. 1.3)* The resulting emission factors are therefore fairly reliable. However, national factors should be used if known.

The indicator attempts to provide as many country emission factors as possible. If your country is not shown then the default value should be used, or a national factor if available.

Emission factors on an international scale could only be calculated for 1996 because of the availability of data. There is a potential for collaboration between the IEA and UNEP to ensure these factors are periodically updated to reflect changes in national energy mixes.

The factors have been calculated by taking CO_2 emissions from public electricity and heat production which incorporate emissions from public electricity generation, public combined heat and power generation and public heat plants. Total emissions are then divided by total electricity production, including electricity from nuclear power and renewables, which are assumed to have zero CO_2 emissions [28], to arrive at an emission factor of tonnes of CO_2 per kWh of electricity produced.

Companies using Worksheet 4.2 should input their total electricity usage in kWh (excluding electricity from private CHP, which is dealt with under section 8.3), in the column next to their country of location. The next step is to multiply electricity usage by the emission factor for your country and enter it in the final column. There should be only one figure for CO_2 from electricity.

Table 12 gives a comprehensive list of country electricity emission factors for 1990 and 1996. This will be updated as and when the data become available.

Some countries in the table have an emissions level of zero for 1990. These tend to be Economies In Transition (EIT's) from Annex B of the Kyoto Protocol. There is a lack of data in IEA statistics for these countries for 1990, reflecting the difficulty of data collection during that period. The default emission factor for 1990 is therefore of limited use because many countries are not included. It is suggested that users from former

[28] Note that this is an approximation, CO_2 emissions also occur in the operation and management of a nuclear power station even if to a much smaller extent.

Eastern Block countries, defined as EIT's for the purposes of the Protocol, attempt to create their own emission factors from national data.

Table 12: Electricity emission factors for different countries for 1990 and 1996 (tCO_2/kWh)

COUNTRY	1990 Emission factor	1996 Emission factor	COUNTRY	1990 Emission factor	1996 Emission factor
Albania	0.000228	0.000019	**Korea**	0.000317	0.000297
Algeria	0.000487	0.000620	**Kuwait**	0.000591	0.000512
Argentina	0.000320	0.000301	**Kyrgyzstan**	0.000000	0.000106
Armenia	0.000000	0.000247	**Latvia**	0.000000	0.000172
Australia	0.000777	0.000791	**Lebanon**	0.001833	0.000652
Austria	0.000192	0.000155	**Libya**	0.000471	0.000626
Azerbaijan	0.000000	0.000150	**Lithuania**	0.000000	0.000142
Bahrain	0.001014	0.000767	**Luxembourg**	0.000000	0.000425
Bangladesh	0.000604	0.000540	**Malaysia**	0.000664	0.000594
Belarus	0.000000	0.000301	**Mexico**	0.000523	0.000508
Belgium	0.000289	0.000281	**Moldova**	0.000000	0.000535
Bolivia	0.000286	0.000269	**Morocco**	0.000674	0.000632
Bosnia-Herzegovina	0.000000	0.000943	**Nepal**	0.000000	0.000017
Brazil	0.000026	0.000032	**Netherlands**	0.000516	0.000435
Brunei	0.001015	0.000711	**New Zealand**	0.000103	0.000099
Bulgaria	0.000000	0.000419	**Norway**	0.000001	0.000002
Canada	0.000189	0.000163	**Pakistan**	0.000410	0.000438
Chile	0.000274	0.000318	**Paraguay**	0.000000	0.000133
China	0.000710	0.000772	**Peru**	0.000057	0.000014
Colombia	0.000178	0.000117	**Poland**	0.000464	0.000609
Croatia	0.000000	0.000217	**Portugal**	0.000494	0.000384
Cuba	0.000629	0.000654	**Romania**	0.000473	0.000304
Czech Republic	0.000539	0.000420	**Russia**	0.000000	0.000282
Denmark	0.000454	0.000446	**Singapore**	0.000890	0.000622
Ecuador	0.000196	0.000307	**Slovak Republic**	0.000306	0.000297
Egypt	0.000546	0.000561	**South Africa**	0.000796	0.000770
Estonia	0.000000	0.000747	**Spain**	0.000408	0.000322
Finland	0.000202	0.000249	**Sri Lanka**	0.000003	0.000205
France	0.000057	0.000040	**Sweden**	0.000040	0.000062
FYROM	0.000698	0.000825	**Switzerland**	0.000008	0.000003
Georgia	0.000000	0.000049	**Syria**	0.000546	0.000650
Germany	0.000460	0.000419	**Tajikistan**	0.000000	0.000068
Greece	0.000971	0.000812	**Thailand**	0.000619	0.000618
Hungary	0.000379	0.000362	**Tunisia**	0.000578	0.000522
Iceland	0.000002	0.000001	**Turkey**	0.000492	0.000461
India	0.000761	0.000890	**Turkmenistan**	0.000000	0.000731
Iran	0.000541	0.000534	**UK**	0.000632	0.000477
Iraq	0.000459	0.000554	**Ukraine**	0.000000	0.000376
Ireland	0.000724	0.000716	**United Arab Emirates**	0.000616	0.000783
Israel	0.000814	0.000801	**Uruguay**	0.000040	0.000100
Italy	0.000488	0.000420	**USA**	0.000546	0.000503
Japan	0.000346	0.000321	**Uzbekistan**	0.000000	0.000432
Jordan	0.000720	0.000791	**Venezuela**	0.000237	0.000176
Kazakhstan	0.000000	0.001312			
World	**0.000489**	**0.000466**	**Non-OECD Europe**	**0.000496**	**0.000420**
Africa	**0.000660**	**0.000663**	**Former USSR**	**0.000417**	**0.000328**
Middle East	**0.000632**	**0.000650**	**Latin America**	**0.000184**	**0.000164**
			Asia (excl. China)	**0.000658**	**0.000724**

Source: IEA, 1998/9

8.3 Combined Heat and Power

This appendix, to be used in conjunction with Worksheets 4.2 and 4.3, describes how to calculate CO_2 emissions from combined heat and power (CHP) systems. The sections on CHP used in these guidelines have been adapted from the UK DETR's *Environmental Reporting Guidelines*. Although the information given by the DETR is designed for use in the UK, the CHP calculations are just as applicable to companies elsewhere. The method for calculating CHP requires knowledge of the quantity of fuel used and of how much electricity and heat is generated. Emission factors calculated by the IPCC are then used to convert the fuel used to CO_2 emissions. Table 11, Appendix 8.1, lists the IPCC emission factors for different fuels.

Users should now read the following sections in order to decide which section applies to their use of CHP and then follow the appropriate instructions to calculate CO_2 emissions from CHP.

8.3.1 Do you IMPORT electricity or heat generated by CHP?

YES GO TO SECTION 8.3.4
NO GO TO SECTION 8.3.2

8.3.2 Do you EXPORT some of the electricity or heat from your CHP?

YES GO TO SECTION 8.3.3
NO

- Work out what fuel types CHP uses
- Work out the quantities of the fuels used over the year
- Using the conversion factors in Worksheet 4.1, calculate CO_2 from fuel use and insert the figure in Column 3 of Worksheet 4.3

8.3.3 EXPORTING electricity or heat from your CHP

If you export some of the electricity or heat from CHP then you need to work out the amount that you export in terms of its CO_2 equivalent. You can then subtract this from your total CO_2. This is because the CO_2 from electricity is attributed to the end user, not the generator, for this type of indicator.

If you use more than one fuel in your CHP read **Section 8.3.5** before going any further.

Enter your data in the boxes provided.

Step 1
Calculate the Total CO_2 from fuel use for your CHP, referring to section 8.3.5 if you use more than one type of fuel. This calculation is the same as that for 8.3.2.

Enter the total in this box: [ ] **= TOTAL** CO_2

Step 2

Requires you to work out the CO_2 emission factor for the electricity you produce. This is done by dividing the amount of CO_2 your CHP produces by the amount of electricity and heat that is produced. The following formulas should be used.

2 X Amount of Fuel used in kWh X t CO_2/kWh Emission Factor (Worksheet 4.1)
2 X Electricity Produced in kWh + Heat Produced in kWh

[ ] = **tCO_2 per kWh of Electricity Produced**

Step 3

Is similar to Step 2 but calculates the CO_2 emission factor for the heat you produce.

Amount of Fuel used in kWh X t CO_2/kWh Emission Factor (Worksheet 4.1)
2 X Electricity Produced in kWh + Heat Produced in kWh

[ ] = **tCO_2 per kWh of Heat Produced**

Step 4

Requires you to enter the amounts of electricity and heat you export, in kWh. This is multiplied by the new emission factors that you have calculated in steps 2 and 3. This gives you a total for the CO_2 emissions you have exported.

KWh of Electricity exported X **tCO_2 per kWh of electricity produced (Step 2)**

[ ] = **CO_2 From Electricity Export**

KWh of Heat exported X **tCO_2 per kWh of Heat produced (Step 3)**

[ ] = **CO_2 From Heat Export**

Add the two figures together to give your total export of CO_2

[ ] = **Total CO_2**

Step 5

Finally, you need to subtract the CO_2 you have exported from the total CO_2 that is produced, given in the box in Step 1. This gives your total CO_2 from CHP, taking into account the CO_2 exported. The final figure should be entered in Column 2 in Worksheet 4.3.

8.3.4 IMPORTING electricity or heat generated by CHP

If you import electricity from a public CHP plant, you should use Worksheet 4.2. This is because the electricity factors used in Worksheet 4.2 incorporate public CHP schemes in the energy mix.

If, however, you import from a private CHP plant, you should get in contact with the supplier of the electricity/heat. The calculation for CO_2 emissions from the electricity/heat you import is the same as that in 8.3.3, but instead you add the CO_2

to your total rather than subtracting it because you become accountable for those emissions. You need to obtain the following data from your supplier to perform the calculation.

- Type of Fuel
- Total Amount used in original units and in electricity and heat
- Amount of electricity and heat they have generated
- Total electricity and heat you have been supplied/imported

Use the boxes in 8.3.3 to calculate the CO_2 emissions from the electricity/heat you import and insert the total in Column 1 in Worksheet 4.3.

8.3.5 Your CHP Uses MORE THAN ONE FUEL

There are two options to consider if you use a mix of fuels for your CHP and you also export some of your electricity or heat.

a) Calculate the total CO_2 from all the fuels you have used in your CHP and then divide by the total fuel input to give you an average emission factor, which can be used in 8.3.3. For example:

Fuel	Amount		Emission factor		t CO_2
Coal	500	X	1.85	=	925
Refinery Feedstock	3502	X	3.25	=	11382
Petroleum Coke	45	X	3.09	=	139
Totals	**4047**				**12446**

Total CO_2 / Total Fuel Input = CO_2 Emission factor

12445.55 / 4047 = 3.075 t CO_2 per tonne of fuel

b) Alternatively, if you want to be more accurate, you can go through the calculation process in 8.3.3 for each individual fuel. Although more time-consuming, this would be more accurate than using one average emission factor for all the fuels you use.

When you have decided which method you are going to use, work through section 8.3.3.

8.4 Road Transport

Road transport data have been taken from that provided by INFRAS and subsequently the DETR, 1999. The DETR report[29] focuses on emissions from driving conditions in the UK. In the absence of quality data for the rest of the world, this information is taken as being applicable to Europe. Other countries should strive to find national data. When applying these data to your company this must be borne in mind.

Calculations for road transport emissions require a two-stage process:

Stage one: Requirement of information for all transport modes in the appropriate units.

Vehicle transport fuels	Units
Petrol	Litres
Diesel	Litres
LPG	Litres

Stage two: Application of appropriate emission factors to the energy sources to produce carbon dioxide equivalents using the same emission factors provided for fuel emissions (listed in Worksheet 4.1).

29 Environmental Reporting – guidelines for company reporting on greenhouse gas emissions, 1999

8.5 Unit. Kilometre Transport

Calculations for transport are based on data provided by INFRAS (1999). INFRAS has studied vehicle emissions for a number of pollutants and a range of driving conditions, vehicle types, fuel types and start-up conditions. The INFRAS data are based on studies of German conditions. However, they also cover the standard EU EURO3, 4 and 5 vehicle classifications. Although the study is based in Germany, it is the most comprehensive study of vehicle emissions to date. It is possible to pick out average conditions from the data that could be applied to different countries, based on vehicle mixes, road speed limits, levels of congestion etc.

For the purposes of this indicator, the INFRAS data reflect average driving conditions for urban, rural and highway conditions. They set an incline variance of ±2 per cent and have the ability to forecast emission levels for different years based on anticipated changes in vehicle mix and fuel type and on the degree to which exhaust standards will change. The emission factors used should be fairly representative of average driving conditions. If a company is able to obtain specific national data on car emissions, it is advisable to use that data.

In the absence of a world-wide study on vehicle emissions, the INFRAS study represents an excellent way of manipulating data for individual circumstances.

Information for non-road transport was taken from INFRAS 1995 and the DETR. Both groups have considerable experience in emissions from travel and therefore it was decided to combine research by both. The data for air travel were taken from the DETR report and were calculated using data from various airlines. Although tailored for the UK, the figures represent the most reliable at present for air travel. Figures for train and shipping emissions are taken from INFRAS, 1995.

The whole area of emissions from non-road transport needs much more research, especially at the world level, so that reliable emission factors can be calculated for individual countries.

Information requirement of 'non-road' transport and appropriate units

Transport Mode	Units
Air	Passenger.km
Air	Tonnage.km
Train	Passenger.km
Train	Tonnage.km
Inland shipping	Tonnage.km
Marine shipping	Tonnage.km

8.6 Process Related Sectors

POTENTIAL EMISSIONS FROM INDUSTRIAL PROCESSES						
Process	**Greenhouse Gases**					
	CO_2	**CH_4**	**N_2O**	**PFC**	**SF_6**	**HFC**
Mineral Products						
Cement production	×					
Lime production	×					
Limestone use	×					
Soda ash production and use	×					
Asphalt roofing						
Brick manufacture						
Road paving						
Other	×	×				
Chemical industry						
Ammonia	×					
Nitric acid			×			
Adipic acid			×			
Urea			×			
Carbides	×	×				
Caprolactam			×			
Petrochemicals		×	×			×
Metal Production						
Iron, steel and ferroalloys	×	×				
Aluminium	×	×		×	×	
Magnesium	×				×	
Other metals		×			×	
Energy Industry						
Coal mining	×	×				
Solid fuel transformation	×					
Oil production	×	×				
Gas production and distribution	×	×				
Other						
Pulp and paper						
Food and drink						
Production of halocarbons				×	×	×
Use of halocarbons and SF_6				×	×	×
Organic waste management	×	×				
Other sources	×	×	×	×	×	×

Source: IPCC, 1996a

The table does not cover all potential GHG's or industrial sources. A cross in the table does not imply that the emission estimations methodology is available in these guidelines or that the emission of a given source and gas is always significant. The table is intended as a simple guide to help companies identify potential emission sources.

8.7 Conversion Tables

General Conversion Factors for Energy

To:	**TJ**	**Gcal**	**Mtoe**	**MBtu**	**GWh**
From:	***multiply by:***				
TJ	1	238.8	2.388×10^{-5}	947.8	0.2778
Gcal	4.1868×10^{-3}	1	10-7	3.968	1.163×10^{-3}
Mtoe	4.1868×10^{4}	10^{7}	1	3.968×10^{7}	11630
MBtu	1.0551×10^{-3}	0.252	2.52×10^{-8}	1	2.931×10^{-4}
GWh	3.6	860	8.6×10^{-5}	3412	1

Conversion Factors for Mass

To:	**kg**	**t**	**lt**	**st**	**lb**
From:	***multiply by:***				
kilogram (kg)	1	0.001	9.84×10^{-4}	1.102×10^{-3}	2.2046
tonne (t)	1000	1	0.984	1.1023	2204.6
long ton (lt)	1016	1.016	1	1.120	2240.0
short ton (st)	907.2	0.9072	0.893	1	2000.0
pound (lb)	0.454	4.54×10^{-4}	4.46×10^{-4}	5.0×10^{-4}	1

Conversion Factors for Volume

To:	**gal U.S.**	**gal U.K**	**bbl**	**ft^3**	**l**	**m^3**
From:	***multiply by*:**					
U.S. Gallon (gal)	1	0.8327	0.02381	0.1337	3.785	0.0038
U.K. Gallon (gal)	1.201	1	0.02859	0.1605	4.546	0.0045
Barrel (bbl)	42.0	34.97	1	5.615	159.0	0.159
Cubic foot (ft^3)	7.48	6.229	0.1781	1	28.3	0.0283
Litre (l)	0.2642	0.220	0.0063	0.0353	1	0.001
Cubic metre (m^3)	264.2	220.0	6.289	35.3147	1000.0	1

8.8 Corporate Environmental Reports Surveyed for Original Indicator (1997)

The calculations and policies on carbon impacts in these corporate environmental reports formed the basis for the methodology set out in this document.

Companies	Companies
3M	National Power
Anglian Water	National Westminster Bank
ASG	Neste
Astra	Noranda
BASF	Norsk Hydro
BHP	Norske Skeg
Body Shop	Northern Telecom
British Petroleum	Northern Electric
British Airways	Northumbrian Water
British Gas	Novartis
British Telecom	Novo Nordisk
Cargill	Nuclear Electric
Danish Steel	Nuclear Electric
Daimlar-Benz	Ontario Hydro
Dow Chemicals	P&O
DuPont	Polaroid
Eastern Electricity	Powergen
Electrolux AB	Proctor & Gamble
ELF Atochem	Roche
ENSO	Royal Dutch & Shell
ESKOM	SAS
Fiat	Scottish Power
Glaxo Wellcome	Severn Water
General Motors	South West Water
Henkel	Statoil
HL & H Timber Holdings	Swiss Bank Corp.
IBM	Tarmac
ICI	Texaco
ING Group	Thames Water
Intel	Thorn EMI
Inter-Continental	Tioxide
J Sainsbury	Unilever
Kvaerner	Volkswagon
Eli Lilly	Volvo
London Electric	Welsh Water
Migror	WMC
MoDo	
Monsanto	

8.9 Annex 1 Countries to the Kyoto Protocol

Table 13: Annex 1 countries to the Kyoto Protocol and emission reduction requirements

COUNTRY	EMISSION REDUCTION REQUIRED (base year 1990)	COUNTRY	EMISSION REDUCTION REQUIRED (base year 1990)
Australia	+8	Liechtenstein	-8
Austria	-13	Lithuania*	-8
Belgium	-7.5	Luxembourg	-28
Bulgaria*	-8	Monaca	-8
Canada	-6	Netherlands	-6
Croatia*	-5	New Zealand	0
Czech Republic*	-8	Norway	+1
Denmark	-21	Poland*	-6
Estonia*	-8	Portugal	+27
EU	-8	Romania*	-8
Finland	0	Russian Federation*	0
France	0	Slovakia*	-8
Germany	-21	Slovenia*	-8
Greece	+25	Spain	+15
Hungary*	-6	Sweden	+4
Iceland	+10	Switzerland	-8
Ireland	+13	Ukraine*	0
Italy	-6.5	UK	-12.5
Japan	-6	USA	-7
Latvia*	-8		

NB

Countries marked with a star in the table above represent Economies In Transition.

Under the Protocol, the EU was required to cut its emissions by 8 per cent in relation to 1990 levels. Under Article 3 of the Protocol, groups of countries can collectively reduce their emissions to achieve an overall target. The EU ‘bubble’ countries have therefore redistributed their targets in order to assist in meeting the EU's overall target of 8 per cent.

8.10 Carbon Offsets/Sequestration

Much of the feedback on the original indicator centred on carbon offsets or sinks – the idea that a company or country can offset some of its emissions of GHG's by planting trees in another country or its own country, or by storing CO_2 in another way. Contributors felt that the indicator concentrated on the negative aspects of GHG emissions and not enough was made of a company's attempt to balance its emissions.

Many companies have adopted these methods and started to promote projects in developing countries that will offset their emissions in that country or in the country from which the company originates. The idea of offsets is closely linked with two of the Kyoto mechanisms, the Clean Development Mechanism and Joint Implementation, and under the right conditions can be a useful way for a firm to account for its global warming impact.

However, there are numerous problems associated with carbon offsets that lead the authors not to include them.

1. It is difficult to verify that the emission reductions associated with carbon offsets are real and measurable.
2. Many believe that reductions in emissions should be made domestically or on-site rather than offsetting the emissions somewhere else. There is an implication that offsetting delays the effects of climate change and passes the problem on to someone else, often less fortunate.
3. The purpose behind this indicator is to promote early action to reduce emissions of GHG's and not to offset them. The indicator will show users where there are potential savings to be made financially and in terms of emission reductions.

By profiling GHG emissions over time, in Worksheet 4.9, the indicator allows users to reflect their emission reduction performance. If emissions have been reduced on site through greater efficiency or by switching car fleets to more fuel-efficient cars, then performance will be seen over time. The ability to provide a clear indication of GHG emission trends over time is of primary interest to investors. It is one of the main reasons for developing this accounting methodology and addresses the concern expressed by some commentators that the indicator does not allow benefits to be seen.

9 CONTACT DETAILS

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10 USEFUL INFORMATION

CLIMATE CHANGE/ KYOTO PROTOCOL:

- United Nations Framework Convention on Climate Change

  http://www.UNFCCC.org

OTHER METHODOLOGIES/INITIATIVES:

- IPCC Guidelines

  http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.htm

- DETR Climate Change Page

  http://www.environment.detr.gov.uk/climatechange/index.htm

- WBCSD/WRI Initiative

  http://www.ghgprotocol.org/

UNEP:

http://www.unep.org

ENVIRONMENTAL REPORTING:

- International Corporate Reporting Site

  http://www.enviroreporting.com

- GRI - Global Reporting Initiative

  http://www.globalreporting.org/

11 FEEDBACK FORM

NAME:

ORGANISATION:

HOW EASY WAS THE INDICATOR TO USE?

WHAT METHODS OR DATA OF YOUR OWN HAVE YOU USED?

HAVE YOU FOUND INFORMATION/DATA SPECIFIC TO YOUR COUNTRY/INDUSTRY WHICH COULD HELP OTHERS?

WHAT WAS YOUR OVERALL IMPRESSION?

WHAT AREAS WOULD YOU IMPROVE AND HOW?

HOW WOULD YOU LIKE TO BE KEPT INFORMED?

E-MAIL NEWSLETTER BY ACCESS TO A WEBSITE

OTHER ELECTRONIC WORKSHEET KEPT UP TO DATE

ANY OTHER COMMENTS?

CAN WE USE YOUR COMMENTS IN ANY FURTHER REVISION?

YES NO

Send to:
Ken McGuire, UNEP Insurance Industry Initiative, Palais des Nations, 1211 Geneve 10, Switzerland; **E-Mail: ken.maguire@unep.ch**

"Is not the creation of an indicator a drive to first measure, then control, then reduce emissions? Could the indicator not be seen as a golden opportunity to raise the profile of ever more accurate knowledge of what our factories are doing to the world, year after year?"

Graeme Castles,
Business Development Manager,
British Salt