

PAS 2050:2008

Specification for the assessment of the life cycle greenhouse gas emissions of goods and services



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Foreword

This Publicly Available Specification (PAS) has been prepared by BSI to specify requirements for assessing the life cycle greenhouse gas emissions (GHG) of goods and services. The development of this PAS was co-sponsored by the Carbon Trust and the Department for Environment, Food and Rural Affairs (Defra).

It has been assumed in the preparation of this PAS that the execution of its provisions will be entrusted to a competent person or persons for whose use it has been produced.

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This PAS is not to be regarded as a British Standard, European Standard or International Standard. In the event that this PAS is put forward to form the basis of a full British Standard, European Standard or International Standard, it will be withdrawn.

Presentational conventions

The provisions of this PAS are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is "shall". Its recommendations are expressed in sentences in which the principal auxiliary verb is "should".

Commentary, explanation and general informative material, e.g. Notes, is presented in italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with this PAS does not in itself confer immunity from legal obligations.

0 Introduction

0.1 General information

Climate change has been identified as one of the greatest challenges facing nations, governments, business and citizens over future decades (IPCC 2007 [1]). Past and current actions, including the release of carbon dioxide (CO₂) and other greenhouse gases through human activities such as the burning of fossil fuels, emissions from chemical processes, and other sources of anthropogenic greenhouse gases, will have an effect on future global climate.

While greenhouse gas (GHG) emissions are often viewed at global, national, corporate or organizational levels, emissions within these groupings can arise from supply chains within business, between businesses, and between nations. The GHG emissions associated with goods and services reflect the impact of processes, materials and decisions occurring throughout the life cycle of the goods and services.

PAS 2050 has been developed in response to broad community and industry desire for a consistent method for assessing the life cycle GHG emissions of goods and services. Life cycle GHG emissions are the emissions that are released as part of the processes of creating, modifying, transporting, storing, using, providing, recycling or disposing of goods and services. PAS 2050 recognizes the potential for organizations to use this method to deliver improved understanding of the GHG emissions arising from their supply chains, and to provide a common basis for the comparison and communication of results arising from the use of PAS 2050. Although there is no requirement for communication or standardization of communication techniques in this specification, this PAS supports the assessment of life cycle GHG emissions of goods and services that can be later reported and communicated to stakeholders, including consumers. Where an organization implementing this PAS chooses to communicate specific result of the assessment of GHG emissions, it is required to make other information available as specified in this PAS.

0.2 Background and benefits

PAS 2050 builds on existing life cycle assessment methods established through BS EN ISO 14040 and BS EN ISO 14044 by specifying requirements for the assessment of the life cycle GHG emissions of goods and services. These requirements further clarify the implementation of the above standards in relation to the assessment of GHG emissions of goods and services, and establish additional principles and techniques that

address essential aspects of GHG assessment, including:

- a) business-to-business and business-to-consumer use of partial GHG assessment data in full GHG assessments of goods and services;
- b) scope of greenhouse gases to be included;
- c) criteria for global warming potential data;
- d) treatment of emissions from land use change, and biogenic and fossil carbon sources;
- e) treatment of the impact of carbon storage in products, and offsetting;
- f) requirements for the treatment of GHG emissions arising from specific processes;
- g) data requirements and accounting for emissions from renewable energy generation; and
- h) claims of conformity.

This PAS is intended to benefit organizations, businesses and other stakeholders by providing a clear and consistent method for the assessment of the life cycle GHG emissions associated with goods and services. Specifically, this PAS provides the following benefits:

- a) For organizations that supply goods and services, this PAS:
 - allows internal assessment of the existing life cycle GHG emissions of goods and services;
 - facilitates the evaluation of alternative product configurations, sourcing and manufacturing methods, raw material choices and supplier selection on the basis of the life cycle GHG emissions associated with goods and services;
 - provides a benchmark for ongoing programmes aimed at reducing GHG emissions;
 - allows for a comparison of goods or services using a common, recognized and standardized approach to life cycle GHG emissions assessment; and
 - supports reporting on corporate responsibility.
- b) For consumers of goods and services, this PAS:
 - provides a common basis for reporting and communicating the results of life cycle GHG emissions assessments that supports comparison and uniformity of understanding; and
 - provides an opportunity for greater consumer understanding of life cycle GHG emissions when making purchasing decisions and using goods and services.

1 Scope

This PAS specifies requirements for the assessment of the life cycle GHG emissions of goods and services (collectively referred to as “products”) based on key life cycle assessment techniques and principles. This PAS is applicable to organizations assessing the GHG emissions of products across their life cycle, and to organizations assessing the cradle-to-gate GHG emissions of products.

Requirements are specified for identifying the system boundary, the sources of GHG emissions associated with products that fall inside the system boundary, the data requirements for carrying out the analysis, and the calculation of the results.

This PAS addresses the single impact category of global warming, and does not assess other potential social, economic and environmental impacts arising from the provision of products, such as non-greenhouse gas emissions, acidification, eutrophication, toxicity, biodiversity, labour standards or other social, economic and environmental impacts that may be associated with the life cycle of products. The life cycle GHG emissions of products, calculated using this PAS, do not provide an indicator of the overall environmental impact of these products, such as may result from other types of life cycle assessment.

This PAS does not include product category-specific rules for goods and services; however, it is intended that selected product category-specific rules for goods and services, developed in accordance with BS ISO 14025, will be adopted where available, as specified in this PAS.

It is one of the intentions of this PAS to allow for the comparison of GHG emissions between products, and to enable the communication of this information. However, this PAS does not specify requirements for communication.



2 Normative references

The following referenced documents are indispensable for the application of this PAS. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS EN ISO 14021, *Environmental labels and declarations – Self-declared environmental claims (Type II environmental labelling)*

BS EN ISO 14044:2006, *Environmental management – Life cycle assessment – Requirements and guidelines, Clause 4.3.4.3*

BS EN ISO/IEC 17050-1, *Conformity assessment – Supplier’s declaration of conformity – Part 1: General requirements*

ISO/TS 14048:2002, *Environmental management – Life cycle assessment – Data documentation format, Clause 5.2.2*

IPCC 2006, *Guidelines for National Greenhouse Gas Inventories*. National Greenhouse Gas Inventories Programme, Intergovernmental Panel on Climate Change

Note Subsequent amendments to IPCC 2006 also apply.

IPCC 2007, *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 996 pp., **Chapter 2, Table 2.14**

Note Subsequent amendments to IPCC 2007 also apply.



3 Terms and definitions

For the purposes of this PAS the following terms and definitions apply.

3.1 allocation

partitioning the input or output flows of a process or a product system between the product system under study and one or more other product systems

[BS EN ISO 14044:2006, 3.17]

3.2 anticipated life cycle greenhouse gas emissions

initial estimate of greenhouse gas (see 3.26 for a definition of greenhouse gases) emissions for a product (see 3.37 for a definition of product) that is calculated using secondary data (see 3.43 for a definition of secondary data) or a combination of primary (see 3.36 for a definition of primary activity data) and secondary data, for all processes used in the life cycle of the product

3.3 biogenic

derived from biomass, but not fossilized or from fossil sources (see 3.22 for a definition of fossil)

3.4 biomass

material of biological origin, excluding material embedded in geological formations or transformed to fossil

[Adapted from CEN/TR 14980:2004, 4.3]

3.5 business-to-business

provision of inputs, including products, to another party that is not the end user

3.6 business-to-consumer

provision of inputs, including products, to the end user

3.7 capital goods

goods, such as machinery, equipment and buildings, used in the life cycle of products

3.8 carbon dioxide equivalent (CO₂e)

unit for comparing the radiative forcing of a GHG to carbon dioxide

[BS ISO 14064-1:2006, 2.19]

Note 1 The carbon dioxide equivalent value is calculated by multiplying the mass of a given GHG by its global warming potential (see 3.25 for a definition of global warming potential).

Note 2 Greenhouse gases, other than CO₂, are converted to their carbon dioxide equivalent value on the basis of their per unit radiative forcing using 100-year global warming potentials defined by the Intergovernmental Panel on Climate Change (IPCC).

3.9 carbon sequestration

removal of carbon from the atmosphere

3.10 carbon storage

retaining carbon of biogenic or atmospheric origin in a form other than as an atmospheric gas

3.11 combined heat and power (CHP)

simultaneous generation in one process of useable thermal, electrical and/or mechanical energy

3.12 competent person

person with training, experience or knowledge and other qualities, and with access to the required tools, equipment and information, sufficient to enable them to carry out a defined task

3.13 consumable

ancillary input that is necessary for a process to occur but that does not form a tangible part of the product or co-products arising from the process

Note 1 Consumables include lubricating oil, tools and other rapidly wearing inputs to a process. Consumables differ from capital goods in that they have an expected life of one year or less, or a need to replenish on a one year or less basis.

Note 2 Fuel and energy inputs to the life cycle of a product are not considered consumables.

3.14 consumer

user of goods or services

3.15 co-product

any of two or more products from the same unit process or product system

[BS EN ISO14044:2006, 3.10]

Note Where two or more products can be produced from a unit process, they are considered co-products only where one cannot be produced without the other being produced.

3.16 data quality

characteristics of data that relate to their ability to satisfy stated requirements

[BS EN ISO14044:2006, 3.19]

3.17 downstream emissions

GHG emissions associated with processes that occur in the life cycle of a product subsequent to the processes owned or operated by the organization implementing this PAS

3.18 economic value

market value of a product, co-product or waste (see 3.50 for a definition of waste) at the point of production

3.19 emission factor

amount of greenhouse gases emitted, expressed as carbon dioxide equivalent and relative to a unit of activity

Note For example, kgCO₂e per unit input. Emission factor data would be obtained from secondary data sources.

3.20 emissions

release to air and discharges to water and land that result in GHGs entering the atmosphere

3.21 environmentally extended input–output (EEIO) analysis

method of estimating the GHG emissions (and other environmental impacts) arising from sectors within an economy through the analysis of economic flows

Note Alternative terms, such as economic input-output life cycle assessment (EIO-LCA), input output based life cycle assessment (IOLCA) and hybrid life cycle assessment (HLCA) refer to different approaches to implementing EEIO analysis.

3.22 fossil

derived from fossil fuel or another fossil source, including peat

[Adapted from IPCC 2006 Guidelines for National Greenhouse Gas Inventories, **Glossary**, see **Clause 2**]

3.23 functional unit

quantified performance of a product system for use as a reference unit

[BS EN ISO 14044:2006, 3.20]

3.24 GHG emissions

release of GHGs to the atmosphere

3.25 global warming potential (GWP)

factor describing the radiative forcing impact of one mass-based unit of a given greenhouse gas relative to an equivalent unit of carbon dioxide over a given period of time

[BS ISO 14064-1:2006, 2.18]

Note Carbon dioxide is assigned a GWP of 1, while the GWP of other gases is expressed relative to the GWP of carbon dioxide from fossil carbon sources. **Annex A** contains global warming potentials for a 100-year time period produced by the Intergovernmental Panel on Climate Change. Carbon dioxide arising from biogenic sources of carbon is assigned a GWP of zero in specific circumstances specified in this PAS.



3.26 greenhouse gases (GHGs)

gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere, and clouds

Note The GHGs included in this PAS are specified in Annex A.

3.27 input

product, material or energy flow that enters a unit process

[BS EN ISO 14040:2006, 3.21]

3.28 intermediate product

output from a unit process that is an input to other unit processes involving further transformation within the system

3.29 International Reference Life Cycle Data System (ILCD)

series of technical guidance documents with quality, method, nomenclature, documentation and review requirements for quality ensured life cycle data and studies, coordinated for Europe by the European Commission's Joint Research Centre [2]

3.30 life cycle

consecutive and interlinked stages of a product system, from raw material acquisition or generation of natural resources to end of life, inclusive of any recycling or recovery activity

[Adapted from BS EN ISO 14040:2006, 3.1]

3.31 life cycle assessment (LCA)

compilation and evaluation of inputs, outputs and potential environmental impacts of a product system throughout its life cycle

[BS EN ISO 14040:2006, 3.2]

3.32 life cycle GHG emissions

sum of greenhouse gas emissions resulting from all stages of the life cycle of a product and within the specified system boundaries of the product

Note This includes all emissions that are released as part of the processes within the boundary of the life cycle of the product, including obtaining, creating, modifying, transporting, storing, operating, using and end of life disposal of the product.

3.33 material contribution

contribution from any one source of GHG emissions

of more than 1% of the anticipated life cycle GHG emissions associated with a product

Note A materiality threshold of 1% has been established to ensure that very minor sources of life cycle GHG emissions do not require the same treatment as more significant sources.

3.34 offsetting

mechanism for claiming a reduction in GHG emissions associated with a process or product through the removal of, or preventing the release of, GHG emissions in a process unrelated to the life cycle of the product being assessed

Note An example is the purchase of Certified Emission Reductions generated by Clean Development Mechanism projects under the Kyoto Protocol [3].

3.35 output

product, material or energy that leaves a unit process

[Adapted from BS EN ISO 14044:2006, 3.25]

Note Materials may include raw materials, intermediate products, co-products, products and emissions.

3.36 primary activity data

quantitative measurement of activity from a product's life cycle that, when multiplied by an emission factor, determines the GHG emissions arising from a process

Note 1 Examples of primary activity data include the amount of energy used, material produced, service provided or area of land affected.

Note 2 Primary activity data sources are typically preferable to secondary data sources as the data will reflect the specific nature/efficiency of the process, and the GHG emissions associated with the process.

Note 3 Primary activity data does not include emission factors.

3.37 product

any good or service

Note Services have tangible and intangible elements. The provision of a service can involve, for example, the following:

- a) an activity performed on a consumer-supplied tangible product (e.g. automobile to be repaired);
- b) an activity performed on a consumer-supplied intangible product (e.g. the income statement needed to prepare a tax return);
- c) the delivery of an intangible product (e.g. the delivery of information in the context of knowledge transmission);
- d) the creation of ambience for the consumer (e.g. in hotels and restaurants);

e) software consists of information and is generally intangible and can be in the form of approaches, transactions or procedures.

[Adapted from BS ISO 14040:2006, 3.9]

3.38 product category

group of products that can fulfil equivalent functions

[BS ISO 14025:2006, 3.12]

3.39 product category rules (PCRs)

set of specific rules, requirements and guidelines for developing Type III environmental declarations for one or more product categories

[BS ISO 14025:2006, 3.5]

3.40 product system

collection of unit processes with elementary and product flows, performing one or more defined functions, that models the life cycle of a product

[BS EN ISO 14040:2006, 3.28]

3.41 raw material

primary or secondary material that is used to produce a product

Note Secondary material includes recycled material.

[BS EN ISO 14040:2006, 3.15]

3.42 renewable energy

energy from non-fossil energy sources: wind, solar, geothermal, wave, tidal, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases

[Adapted from Directive 2001/77/EC, Article 2 [4]]

3.43 secondary data

data obtained from sources other than direct measurement of the processes included in the life cycle of the product

Note Secondary data is used when primary activity data is not available or it is impractical to obtain primary activity data.

3.44 system boundary

set of criteria specifying which unit processes are part of a product system

[BS EN ISO 14040:2006, 3.32]

3.45 unit process

smallest portion of a life cycle for which data are analysed when performing a life cycle assessment

3.46 upstream emissions

GHG emissions associated with processes that occur in the life cycle of a product prior to the processes owned, operated or controlled by the organization implementing this PAS

3.47 use phase

that part of the life cycle of a product that occurs between the transfer of the product to the consumer and the end of life of the product

Note For services, the use phase includes the provision of the service.

3.48 use profile

criteria against which the GHG emissions arising from the use phase are determined

3.49 useful energy

energy that meets a demand by displacing another source of energy

Note For example, where heat production from a CHP unit is utilized to meet a demand for heat that was previously met by another form of energy, or meets a new demand for heat that would have required additional energy input, then the heat from the CHP is providing useful energy. Had the heat from the CHP not met a demand, but instead been dissipated (e.g. vented to the atmosphere), the heat would not be considered useful energy (in which case no emissions from the CHP would be assigned to the heat production).

3.50 waste

materials, co-products, products or emissions which the holder discards or intends, or is required to, discard

4 Principles and implementation

4.1 General requirements

Assessment of the GHG emissions of products shall be carried out using LCA techniques. Unless otherwise indicated, the assessment of the life cycle GHG emissions of products shall be made using the attributional approach, i.e. by describing the inputs and their associated emissions attributed to the delivery of a specified amount of the product functional unit.

Note LCA techniques are specified in BS EN ISO 14040 and BS EN ISO 14044. Where the approach described in these standards is incompatible with the requirements of this PAS, the requirements of this PAS take precedence.

4.2 Principles

Organizations claiming conformity with this PAS shall ensure that the assessment of the life cycle GHG emissions of a product is complete, and shall be able to demonstrate that the following principles have been taken into consideration when carrying out the assessment:

- a) **Relevance:** select GHG sources, carbon storage, data and methods appropriate to the assessment of the GHG emissions arising from products;
- b) **Completeness:** include all specified GHG emissions and storage that provide a material contribution to the assessment of GHG emissions arising from products;
- c) **Consistency:** enable meaningful comparisons in GHG-related information;
- d) **Accuracy:** reduce bias and uncertainties as far as is practical;
- e) **Transparency:** where the results of life cycle GHG emissions assessment carried out in accordance with this PAS are communicated to a third party, the organization communicating these results shall disclose GHG emissions-related information sufficient to allow such third parties to make associated decisions with confidence.

Note The above principles are adapted from BS ISO 14064-1:2006, Clause 3.

4.3 Product differentiation

The GHG emissions assessment specified in this PAS shall apply to the product for which the assessment is conducted. Where similar products are being assessed, a separate assessment shall be carried out for each product that is provided to a third party, unless the similar products are provided in such a manner as to

make them indistinguishable from each other by the third party.

4.4 Supporting data

Data supporting the assessment of life cycle GHG emissions, including but not limited to, product and process boundaries, materials, emission factors and emissions, and other data as required in this PAS, shall be documented and a record maintained in a format suitable for analysis and verification for the greater of either five years or the life expectancy of the product.

Note Data records should be made available to support claims of conformity no matter what form of verification is chosen. The basis of support for self verification of conformity is no different from that required for other party verification or independent third party certification (see Clause 10).

4.5 Implementation of this PAS

The assessment of life cycle GHG emissions for products shall be carried out as either:

- a) a business-to-consumer assessment, which includes the emissions arising from the full life cycle of the product; or
- b) a business-to-business assessment, which includes the GHG emissions released up to and including the point where the input arrives at a new organization (including all upstream emissions).

Note 1 The above two approaches are respectively referred to as "cradle-to-grave" approach (see BS EN ISO 14044) and "cradle-to-gate" approach (see BS EN ISO 14040).

Note 2 See 6.2 for the assessment of the emissions arising from part of the life cycle of the product for business-to-business assessment purposes.



5 Emission sources, offsetting and unit of analysis

5.1 Scope of GHG emissions

The assessment of life cycle GHG emissions shall include the gasses listed in **Annex A**.

5.1.1 Global warming potential (GWP)

GHG emissions shall be measured by mass and shall be converted into CO₂e emissions using the latest IPCC 100-year global warming potential (GWP) coefficients (**Annex A**), except where otherwise specified in this PAS.

Note For example, methane has a GWP coefficient of 25, and 1 kg of methane is equivalent to 25 kg CO₂e in terms of its GWP.

5.1.2 Aircraft emissions

No multiplier or other correction shall be applied to the GWP of emissions arising from aircraft transport.

Note The application of a multiplier for aircraft emissions will be given further consideration in future revisions of this PAS, once there is scientific consensus regarding the approach to be taken.

5.2 Time period for assessment of GHG emissions

The assessment of the impact of GHG emissions arising from the life cycle of products shall be the CO₂e impact of the GHG emissions over the 100-year period following the formation of the product (i.e. the 100-year assessment period).

Emissions arising from all life cycle phases of the product, except the use phase (see **6.4.8**) and the final disposal phase (see **6.4.9**), shall be treated as a single release of emissions at the beginning of the 100-year assessment period.

Where all GHG emissions arising from the use phase or from final disposal occur within one year following the formation of the product, those emissions shall be treated as a single release of emissions at the beginning of the 100-year assessment period. Where emissions arising from the use phase or from final disposal occur over more than one year, a factor shall be applied to represent the weighted average time the emissions are present in the atmosphere during the 100-year assessment period (for use phase emissions see **6.4.8.1** and **Annex B**; for emissions from final disposal see **6.4.9.1** and **Annex B**).

Note Examples of use phase and final disposal emissions occurring over more than one year include emissions from

the use phase of a long-life light bulb, or emissions arising from final disposal of the product at a later stage (e.g. from landfill or from incineration after the first year).

The impact of carbon storage in products shall be as described in **5.4**.

5.3 Sources of GHG emissions

The assessment shall include GHG emissions arising from processes, inputs and outputs in the life cycle of a product, including but not limited to:

- a) energy use (including energy sources, such as electricity, that were themselves created using processes that have GHG emissions associated with them);
- b) combustion processes;
- c) chemical reactions;
- d) refrigerant loss and other fugitive gases;
- e) operations;
- f) service provision and delivery;
- g) land use change;
- h) livestock and other agricultural processes;
- i) waste.

*Note See **6.2** for the assessment of the emissions arising from part of the life cycle of the product for business-to-business assessment purposes, and **Clause 7** for data sources.*

5.3.1 CO₂ emissions originating from fossil and biogenic carbon sources

CO₂ emissions arising from fossil carbon sources shall be included in the calculation of GHG emissions from the life cycle of products.

CO₂ emissions arising from biogenic carbon sources shall be excluded from the calculation of GHG emissions from the life cycle of products, except where the CO₂ arises from land use change (see **5.5**).

5.3.2 Non-CO₂ emissions originating from fossil and biogenic carbon sources

Non-CO₂ emissions arising from both fossil and biogenic carbon sources shall be included in the calculation of GHG emissions from the life cycle of products. The GWP factor for non-CO₂ emissions originating from biogenic carbon sources shall be corrected to take into account the sequestration of the CO₂ that gave rise to the biogenic carbon source.

5.4 Carbon storage in products

Where atmospheric CO₂ is taken up by a product, and that product is not a living organism, the impact of this carbon storage over the 100-year assessment period shall be included in the assessment of the life cycle GHG emissions of the product, subject to the conditions described in 5.4.3 and 5.4.4.

Where carbon of biogenic origin forms part of a product, the impact of this carbon storage over the 100-year assessment period shall be included in the assessment of the life cycle GHG emissions of the product, subject to the conditions described in 5.4.1 to 5.4.4.

Note Carbon storage may arise where biogenic carbon forms part or all of a product (e.g. wood fibre in a table), or where atmospheric carbon is taken up by a product over its life cycle (e.g. cement).

5.4.1 Eligible products for the assessment of stored biogenic carbon

For products containing carbon of biogenic origin, the impact of carbon storage shall be included in the

assessment of the life cycle GHG emissions of the product where:

- a) the product is not for human or animal ingestion (i.e. not a food or feed);
- b) more than 50% of the mass of carbon of biogenic origin in the product remains removed from the atmosphere for one year or more following production of the product; and
- c) the material containing the biogenic carbon is obtained from either:
 - i) an input that is the result of human actions that cause its formation for the purpose of using it as an input to a process (e.g. managed forestry); or
 - ii) a recycled or re-use input that contains material that is demonstrated to comply with point (i) above.

Note 1 The purpose of a) is to limit the need to carry out a carbon storage assessment to non-food items; the purpose of b) is to ensure that this provision is not required to be implemented for products of biogenic origin that have a short life span; the purpose of c) is to ensure that the storage of biogenic carbon in products is additional to that



which would have occurred without human intervention.

Note 2 Storage of biogenic carbon in products will vary depending on the type of product, the mean life span of the product, its rate of recycling and its disposal route (e.g. landfill, incineration).

Note 3 While forest management activities may result in additional carbon storage in managed forests through the retention of forest biomass, this potential source of storage is not included in the scope of this PAS.

5.4.2 Treatment of stored biogenic carbon

5.4.2.1 Treatment of biogenic carbon at disposal

Where products are disposed of in a manner that prevents some or all of the biogenic carbon being re-emitted to the atmosphere within the 100-year assessment period, the portion of biogenic carbon not re-emitted to the atmosphere shall be treated as stored carbon for the purpose of this PAS (see 5.4.3 for the assessment method).

5.4.2.2 Treatment of biogenic carbon in recycled material

Where a product is recycled within the 100-year assessment period, the impact of carbon storage shall be determined for the product giving rise to the recycled material up to the point at which recycling occurred.

Note A product using recycled biogenic material receives a storage benefit from the carbon stored in the recycled material in accordance with this section.

5.4.2.3 Treatment of CO₂ emissions arising from products containing biogenic carbon

Where a product containing carbon of biogenic origin degrades and releases CO₂ to the atmosphere, the CO₂ emissions arising from the biogenic carbon shall not be included in the assessment of emissions associated with the product.

Note CO₂ emissions from products containing biogenic carbon are included in the assessment of the life cycle GHG emissions via the calculation of the weighted average carbon stored over the 100-year assessment period (see 5.4.3), and do not need to be included here.

5.4.2.4 Treatment of non-CO₂ GHG emissions from products containing biogenic carbon

Non-CO₂ GHG emissions arising from products containing carbon of biogenic origin over the 100-year assessment period shall form part of the life cycle emissions of the product being assessed. Where non-CO₂ GHG emissions are captured and used for energy recovery, the treatment of such emissions shall be in accordance with 8.2.3.

Note Non-CO₂ emissions, such as CH₄, may arise through the decomposition of the product in any form or location, such as in landfill.

5.4.3 Calculation of the CO₂ impact of stored carbon

5.4.3.1 Weighted average of stored biogenic carbon and atmospheric CO₂ taken up by products

The impact of carbon storage shall be determined from the weighted average of the biogenic carbon (measured as CO₂) in a product, or atmospheric CO₂ taken up by a product, and not re-emitted to the atmosphere over the 100-year assessment period. The method for calculating the weighted average carbon storage impact shall be that given in Annex C.

5.4.3.2 Inclusion of the GHG impact of stored carbon

The weighted average carbon storage impact calculated in accordance with 5.4.3.1 shall be included as a negative CO₂e value in the assessment of GHG emissions arising from the life cycle of the product.

5.4.4 Recording the basis of the carbon storage assessment

Where the assessment of the life cycle GHG emissions of a product includes the impact of stored carbon, the data sources from which the impact of stored carbon was calculated, together with the carbon storage profile of the product over the 100-year assessment period, shall be recorded and retained (see 4.4).

5.5 Inclusion and treatment of land use change

The GHG emissions arising from direct land use change shall be assessed for any input to the life cycle of a product originating from agricultural activities, and the GHG emissions arising from the direct land use change shall be included in the assessment of GHG emissions of the product.

The GHG emissions occurring as a result of direct land use change shall be assessed in accordance with the relevant sections of the IPCC Guidelines for National Greenhouse Gas Inventories (see Clause 2). The assessment of the impact of land use change shall include all direct land use change occurring on or after 1 January 1990. The total GHG emissions arising from direct land use change shall be included in the GHG emissions of products arising from this land. One-twentieth (5%) of the total emissions arising from the land use change shall be included in the GHG emissions of these products in each year over the 20 years following the change in land use.



Note 1 Where it can be demonstrated that the land use change occurred more than 20 years prior to the assessment being carried out in accordance with this PAS, no emissions from land use change should be included in the assessment as all emissions resulting from the land use change would be assumed to have occurred prior to the application of the PAS.

Note 2 Direct land use change refers to the conversion of non-agricultural land to agricultural land as a consequence of producing an agricultural product or input to a product on that land. Indirect land use change refers to the conversion of non-agricultural land to agricultural land as a consequence of changes in agricultural practice elsewhere.

Note 3 While GHG emissions also arise from indirect land use change, the methods and data requirements for calculating these emissions are not fully developed. Therefore, the assessment of emissions arising from indirect land use change is not included in this PAS. The inclusion of indirect land use change will be considered in future revisions of this PAS.

Note 4 It is assumed that prior to the land use change taking place the net GHG emissions arising from the land were zero.



5.5.1 Limited traceability of agricultural products

The GHG emissions from land use change for selected countries, by previous and current land use, shall be as shown in **Annex E**. The following hierarchy shall apply when determining the GHG emissions arising from land use change occurring after 1 January 1990:

1. Where the country of production of the agricultural crop is known and the previous land use is known, the GHG emissions arising from land use change shall be those emissions resulting from the change in land use from the previous land use to the current land use in that country;
2. Where the country of production of the agricultural crop is known, but the former land use is not known, the GHG emissions arising from land use change shall be the highest potential emissions arising from land use change in that country;
3. Where the country of production of the agricultural crop is not known, the GHG emissions arising from land use change shall be the highest potential emissions arising from land use change for all countries (i.e. it shall be assumed that GHG emissions associated with land use change are equivalent to those emissions arising from the conversion of forest land to annual cropland in Malaysia).

Note By requiring worst-in-class data where the land use change impact of an input cannot be determined, an incentive is provided to report the origin of agricultural products. This approach is adopted in preference to an approach of using average data in cases of limited



traceability of agricultural products, as an average approach would encourage poor reporting in areas of high land use change impact.

5.5.2 Limited knowledge of the timing of land use change

Where the timing of land use change cannot be demonstrated to be prior to 1 January 1990, it shall be assumed that the land use change occurred on 1 January of either:

- a) the earliest year in which it can be demonstrated that the land use change had occurred; or
- b) on 1 January of the year in which the assessment of GHG emissions is being carried out.

5.5.3 Recording the type and timing of land use change

Data sources, location and timing of land use change associated with inputs to products shall be recorded and retained (see 4.4) by the organization implementing this PAS.

Note Knowledge of the prior land use can be demonstrated using a number of sources of information, such as satellite imagery and land survey data. Where records are not available, local knowledge of prior land use can be used.

5.6 Treatment of soil carbon change in existing agricultural systems

Changes in the carbon content of soils, either emissions or sequestration, other than those arising from direct land use change (see 5.5) shall be excluded from the assessment of GHG emissions under this PAS.

Note 1 The above requirement refers to changes such as tilling techniques, crop types and other management actions taken in relation to agricultural land. It does not refer to the impact of land use change on carbon emissions which is included in 5.5.

Note 2 While it is recognized that soils play an important part in the carbon cycle, both as a source and sink for carbon, there is considerable uncertainty regarding the impact of different techniques in agricultural systems. For this reason, emissions and sequestration arising from changes in soil carbon are outside the scope of this PAS. Inclusion of carbon storage in soils will be considered further in future revisions of this PAS.

5.7 Offsetting

GHG emissions offset mechanisms, including but not limited to, voluntary offset schemes or nationally or internationally recognized offset mechanisms, shall not be used at any point in the life cycle of the product in

order to claim reduction in the emissions associated with the product.

Note It is the intention that this PAS reflects the GHG intensity of the production process prior to the implementation of external measures to offset GHG emissions. The use of an energy source that results in lower GHG emissions to the atmosphere and therefore achieves a lower emission factor, such as renewable electricity (see 7.9.3) or conventional thermal generation with carbon capture and storage, is not a form of offsetting.

5.8 Unit of analysis

Assessment of the GHG emissions arising from the life cycle of products shall be carried out in a manner that allows the mass of CO₂e to be reported per functional unit for the product. The functional unit shall be reported to two significant figures.

Where a product is commonly available on a variable unit size basis, the calculation of GHG emissions shall be proportional to the unit size (e.g. per kilogram or per litre of goods sold, or per month or year of a service provided).

Note 1 For services the appropriate reporting unit may be established on a time (e.g. annual emissions associated with an internet service) or event basis (e.g. per night emissions associated with a hotel stay).

Note 2 The functional unit may differ according to the purpose of the assessment activity. For example, the functional unit for internal organizational reporting may differ from the functional unit communicated to consumers.



6 System boundary

6.1 Establishing the system boundary

Where a relevant Product Category Rule (PCR) developed in accordance with BS ISO 14025 exists for the product being considered, and the system boundary in the PCR does not conflict with the system boundary established in this clause, the boundary conditions specified in the PCR shall form the system boundary for the product.

Where a PCR developed in accordance with BS ISO14025 does not exist for the product being considered, the system boundary shall be clearly defined for each product and its underlying processes in accordance with 6.4.

Note 1 Consideration should be given to the material contribution that different processes within the system boundary will make to the total GHG emissions of a product (see 6.3).

Note 2 A list of existing PCRs can be found at www.environdec.com.

6.2 Partial GHG emission information for business-to-business assessment

The system boundary for the assessment of GHG emissions for an input that is made available or used in a business-to-business manner shall include all

emissions that have occurred up to, and including, the point where the input arrives at a new organization (including all upstream emissions). Downstream emissions shall be excluded from the system boundary GHG emissions assessments carried out for business-to-business assessments.

Note The purpose of partial GHG emission assessment is to facilitate the provision of consistent GHG emission information within the supply chain for products, and to simplify the implementation of this PAS. This cradle-to-gate perspective of the supply chain allows incremental addition of GHG emissions at different stages of the supply until the product is provided to the consumer (where the assessment of GHG emissions includes the emissions arising from the entire life cycle).

6.2.1 Use of partial GHG emissions assessment information

Partial GHG emissions assessment information shall not be disclosed to consumers as representing a full assessment of the life cycle GHG emissions of a product.

Note 1 Partial GHG emission assessment information should be disclosed to other organizations that may use the product for which the partial GHG emission assessment has been carried out as an input to a process, where this process is not the use phase of the product or downstream of the use phase of the product.

Note 2 For example, the assessment of the GHG emissions associated with the production of flour that is subsequently supplied to a bakery would not include emissions arising from subsequent processes where the flour was provided to a subsequent business. However, a bakery supplying bread to consumers would assess the complete life cycle GHG emissions of the product.

6.2.2 Communication of partial GHG emissions assessment information

Where data arising from a partial GHG emissions assessment are communicated to a third party, the data shall conform to 5.2.2 of ISO/TS 14048 and the scope of emissions sources included within the partial GHG emissions assessment shall also be communicated to the third party.

6.3 Material contribution and threshold

Calculations carried out in accordance with this PAS shall include all emissions within the system boundary that have the potential to make a material contribution to the life cycle GHG emissions of the product.



Note A preliminary assessment of the sources of GHG emissions in the life cycle of a product may be undertaken using secondary data or through an EEIO approach. This preliminary assessment could provide an overview of the key sources of GHG emissions within the life cycle of the product and identify major contributors to the GHG emissions assessment.

For GHG emissions arising from the life cycle of a product, except those from the use phase, the assessment of GHG emissions shall include:

- a) all sources of emissions anticipated to make a material contribution to the life cycle GHG emissions of the functional unit;
- b) at least 95% of the anticipated life cycle GHG emissions of the functional unit; and
- c) Where a single source of GHG emissions accounts for more than 50% of the potential life cycle GHG emissions of a product, the 95% threshold rule shall apply to the remaining GHG emissions associated with the anticipated life cycle GHG emissions of the product.

For GHG emissions arising from the use phase of a product, the assessment of GHG emissions shall include:

- a) all sources of emissions having the potential to make a material contribution to the emissions of the use phase;
- b) at least 95% of the potential life cycle emissions of the use phase.

Where less than 100% of the anticipated life cycle GHG emissions have been determined, the assessed emissions shall be scaled up to represent 100% of the GHG emissions associated with the functional unit in accordance with **Clause 9**.

6.4 System boundary

The following rules shall define the system boundary for the assessment of the life cycle GHG emissions of products.

Note While the system boundary is defined by the following rules, not all products will have processes or emissions arising from each of the categories.

6.4.1 Raw materials

The GHG emissions resulting from all processes used in the transformation of raw material shall be included in the assessment, including all sources of energy consumption or direct GHG emissions.

Note 1 GHG emissions from raw materials include, but are not limited to: GHG emissions from mining or extracting raw materials (solids, liquids and gases such as iron, oil and natural gas), including emissions from machinery, consumables as well as exploration and development; waste generated at each stage of the extraction and pre-processing of raw materials (see also 6.4.3).

Note 2 Agricultural emissions include, for example, the GHG emissions from farming, fishing and forestry, including emissions from fertilizers (e.g. N₂O emissions arising from the application of nitrogen fertilizer and emissions arising from the production of the fertilizer); emissions from direct land use change and energy intensive atmospheric growing conditions (e.g. heated greenhouse); emissions from crops (e.g. methane from rice cultivation) and livestock (e.g. methane from cattle).

Note 3 Raw materials have zero GHG emissions associated with them when they have not been through any external process transformation, e.g. iron ore before it has been extracted.

6.4.2 Energy

The GHG emissions associated with the provision and use of energy in the life cycle of the product shall be included in the emissions arising from the energy supply system.

Note Emissions from energy include the emissions arising from the life cycle of the energy. This includes emissions at the point of consumption of the energy (e.g. emissions from the burning of coal and gas) and emissions arising from the provision of the energy, including the generation of electricity and heat, and emissions from transport fuels; upstream emissions (e.g. the mining and transport of fuel to the electricity generator or other combustion plant); downstream emissions (e.g. the treatment of waste arising from the operation of nuclear electricity generators); and the growing and processing of biomass for use as a fuel.

6.4.3 Capital goods

The GHG emissions arising from the production of capital goods used in the life cycle of the product shall be excluded from the assessment of the GHG emissions of the life cycle of the product.

Note The treatment of emissions arising from capital goods will be considered further in future revisions of this PAS.

6.4.4 Manufacturing and service provision

The GHG emissions arising from manufacturing and service provision that occur as part of the life cycle of the product, including emissions associated with the use of consumables, shall be included in the assessment of the GHG emissions of the life cycle of the product.

Where a process is used for prototyping a new product, the emissions associated with the prototyping activities shall be allocated to the resulting product(s) and co-product(s) of the process.

6.4.5 Operation of premises

The GHG emissions arising from the operation of premises, including emissions from factories, warehouses, central supply centres, offices, retail outlets, etc., shall be included in the assessment of the GHG emissions of the life cycle of the product.

Note Operation includes the lighting, heating, cooling, ventilation, humidity control and other environmental controls over the premises. An appropriate approach for the division of emissions arising from the operation of, for example, warehouses, would be to use the residence time and volume of space occupied by the product as a basis for the division.

6.4.6 Transport

The GHG emissions arising from road, air, water, rail or other transport methods that form part of the life cycle of the product shall be included in the assessment of the GHG emissions of the life cycle of the product.

Note 1 Emissions associated with environmental control requirements during transport (e.g. refrigerated transport) are included in 6.4.7.

Note 2 GHG emissions from transport include the emissions associated with transporting fuels (e.g. emissions arising from the operation of pipelines, transmission networks and other fuel transport activities).

Note 3 GHG emissions from transport include the emissions arising from transport associated with individual processes, such as the movement of inputs, products and co-products within a factory (e.g. by conveyor belt or other localized transport methods).

Note 4 Where products are distributed to different points of sale (i.e. different locations within a country), emissions associated with transport will vary from store to store due to different transport requirements. Where this occurs, organizations should calculate the average release of GHGs associated with transporting the product based on the average distribution of the product within each country, unless more specific data is available. Where the same product is sold in identical form in multiple countries, country-specific data could be used, or the average could be weighted by the amount of product sold in each country.



6.4.7 Storage

The GHG emissions arising from storage shall be included in the assessment of the life cycle GHG emissions of the product, including:

- a) storage of inputs, including raw materials, at any point in the product life cycle;
- b) environmental controls (e.g. cooling, heating, humidity control and other controls) related to a product at any point in the product life cycle (see 6.4.5 for the operation, including environmental control, of factories in which products may be stored);
- c) storage of products in the use phase (see 6.4.8);
- d) storage prior to re-use or recycling activities (see 8.5).

Note GHG emissions identified under 6.4.7 relate to storage activities not already covered by 6.4.5.

6.4.8 Use phase

The GHG emissions arising from the use of goods or the provision of services shall be included in the assessment of the life cycle GHG emissions of products, subject to the provisions of 6.2 for business-to-business assessments. The emission factor associated with energy used in the use phase of products shall be determined in accordance with 6.4.2.

Note The calculation of GHG emissions from energy use is based on country specific annual average emission factor for energy, unless it can be demonstrated that a different emission factor is more representative of the energy use characteristics of the product. For example, where the use phase includes the consumption of electricity by the consumer in relation to the product being assessed, the country specific annual average emission factor of the electricity would be used; where an identical product is supplied to multiple international markets, the emission factor for the energy used by the product in the use phase would be the average emission factor of the countries where the product is supplied, weighted by the proportion of the product supplied in the different countries.

6.4.8.1 Time period for use phase GHG emissions

All emissions arising from the use phase of the product over the 100-year assessment period shall be included. Where the use phase of a product results in the release of GHG emissions over time, the total emissions projected to occur over the 100-year assessment period shall be included in the assessment of GHG emissions of that product. A factor shall be applied to these emissions to reflect the weighted average time these emissions are present in the atmosphere during the 100-year assessment period (see Annex B).

6.4.8.2 Basis of the use profile

Determination of the use profile for the use phase of products shall be based on a hierarchy of boundary definitions. The order of preference for the basis of the use profile shall be:

1. Product Category Rules (PCRs) that specify a use phase for the product being assessed;
2. published international standards that specify a use phase for the product being assessed;
3. published national guidelines that specify a use phase for the product being assessed;
4. published industry guidelines that specify a use phase for the product being assessed.

Where no method for determining the use phase of products has been established in accordance with points 1-4 above, the approach taken in determining the use phase of products shall be established by the organization carrying out the assessment of GHG emissions for the product.

Where emissions arise from energy use in the use phase, the use profile shall record the emission factor of each energy type used by the product and the source of the emission factor. Where the emission factor is not an annual average emission factor for a single country, the determination of the emission factor shall be recorded and retained (see 4.4).

Note 1 The manufacturer's recommended method for achieving the functional unit (e.g. cooking by oven at a specified temperature for a specified time) may provide a basis for determining the use phase of a product. However, actual usage patterns may differ from those recommended, and the use profile should seek to represent the actual usage pattern.

Note 2 It is anticipated that, over time, PCRs and other published material will increasingly form the basis of use phase emissions assessments.

6.4.8.3 Recording the basis of use phase calculations for products

The basis on which the use phase for products is assessed shall be recorded and retained (see 4.4).

6.4.8.4 Impact of the product on the use phase of other products

Where the operation or application of a product causes a change (either increase or decrease) in the GHG emissions arising from the use phase of another product, this change shall be excluded from the assessment of the life cycle GHG emissions of the product being assessed.

6.4.9 GHG emissions from final disposal

The GHG emissions arising from final disposal (e.g. waste disposed of through landfill, incineration, burial, wastewater) shall be included in the assessment of the life cycle GHG emissions of the product, subject to the provisions of 6.2 for business-to-business assessments.

Note GHG emissions identified under 6.4.9 relate to emissions from waste not already covered in Annex D.

6.4.9.1 Time period for GHG emissions from final disposal

All GHG emissions arising from final disposal over the 100-year assessment period shall be included. Where the final disposal of materials or products results in the release of GHG emissions over time (e.g. decomposition of food waste sent to landfill), the total emissions projected to occur over the 100-year assessment period shall be included in the assessment of GHG emissions of the product giving rise to the disposal. A factor shall be applied to these emissions to reflect the weighted average time the emissions are present in the atmosphere during the 100-year assessment period (see Annex B).

6.4.9.2 Activities following final disposal

Where the emissions from final disposal are diverted to another system (e.g. combustion of methane arising from landfill, combustion of waste timber fibre), the assessment of GHG emissions from the products giving rise to the emissions shall reflect the emissions arising from this diversion, as described in 8.2.

6.5 System boundary exclusions

The system boundary of the product life cycle shall exclude the GHG emissions associated with:

- a) human energy inputs to processes and/or pre-processing (e.g. if fruit is picked by hand rather than by machinery);
- b) transport of consumers to and from the point of retail purchase;
- c) transport of employees to and from their normal place of work; and
- d) animals providing transport services.



7 Data

7.1 General

The data recorded in relation to a product shall include all GHG emissions occurring within the system boundary of that product.

7.2 Data quality rules

When identifying primary activity data and secondary data for use in GHG emissions assessment, preference shall be given as follows:

- a) For time-related coverage: age of data and the minimum length of time over which data are collected, data that are time-specific to the product being assessed shall be preferred;
- b) For geographical specificity: geographical area from which data is collected (e.g. district, country, region), data that are geographically-specific to the product being assessed shall be preferred;
- c) For technology coverage: whether the data relates to a specific technology or a mix of technologies, data that are technology-specific to the product being assessed shall be preferred;
- d) For accuracy of the information (e.g. data, models and assumptions), data that are most accurate shall be preferred;
- e) For precision: measure of the variability of the data values for each data expressed (e.g. variance), data that are more precise (i.e. has the lowest statistical variance) shall be preferred.

In addition, consideration shall be given to the following:

- f) completeness: the percentage of data that are measured, and the degree to which the data represents the population of interest (is the sample size large enough, is the periodicity of measurement sufficient, etc.);
- g) consistency: qualitative assessment of whether the selection of data is carried out uniformly in the various components of the analysis;
- h) reproducibility: qualitative assessment of the extent to which information about the method and data values would allow an independent practitioner to reproduce the results reported in the study;
- i) data sources, with reference to the primary or secondary nature of the data.

Note 1 Adapted from BS EN ISO 14044:2006, 4.2.3.6.2.

Note 2 Assessment of GHG emissions should use data that will reduce bias and uncertainty as far as practicable by using the best quality data achievable. Determination of the

best quality data could be supported by a data scoring framework that allows the different attributes of data quality to be combined.

7.3 Primary activity data

Primary activity data shall be collected from those processes owned, operated or controlled by the organization implementing this PAS. The primary activity data requirement shall not apply to downstream emission sources.

Where the organization implementing this PAS does not contribute 10% or more to the upstream GHG emissions of the product or input prior to its provision to another organization or the end-user, the primary activity data requirement shall apply to the emissions arising from those processes owned, operated or controlled by the first upstream supplier that does contribute 10% or more to the upstream GHG emissions of the product or input.

Primary activity data shall be collected for individual processes or for premises where processes are occurring and shall be representative of the process for which it is collected. Allocation between co-products, where required, shall be carried out in accordance with 8.1.

The requirement to obtain primary activity data shall not apply where implementing the requirement would necessitate the physical measurement of the GHG emissions (e.g. measuring CH₄ emissions from livestock or N₂O emissions from fertilizer application).

Note 1 Where an organization imposes conditions on the supply of products to it, such as a retailer specifying the quality of the product supplied to it or the manner of its packaging, this is evidence of control over the processes upstream of the organization implementing the PAS. In this situation, the requirement for primary activity data applies to the processes upstream of the organization implementing this PAS.

Note 2 Obtaining primary data for operations that are not under the control of the organization implementing the PAS (i.e. upstream emissions) will enhance the ability of the organization to differentiate the GHG assessment of its products from other products.

Note 3 Examples of primary activity data would be the measurement of energy use or material use in a process, or fuel use in transport.

Note 4 To be representative, primary activity data should reflect the conditions normally encountered in the process that are specific to the product being assessed. For example,

if refrigerated storage of a product is required, the primary activity data associated with this refrigeration (e.g. quantity of energy used, and quantity of refrigerant escaped) should reflect the long-term operation of the refrigeration and not those associated with a period of typically higher (e.g. August) or lower (e.g. January) energy consumption or refrigerant release.

Note 5 Emissions from livestock, their manure and soils are treated as secondary data (see 7.4).

7.4 Secondary data

Secondary data shall be used for inputs where primary activity data is not required.

7.4.1 Use of partial GHG assessment information as secondary data

Where data verified as being compliant with this PAS is available for inputs to the life cycle of the product being assessed (i.e. partial GHG emission information, see 6.2), preference shall be given to the use of this data over other secondary data.

7.4.2 Other secondary data

Where secondary data in accordance with 7.4.1 is not available, the data quality rules (see 7.2) shall be used to select the most relevant source of secondary data. Determination of the source of the secondary data (see 7.2 (i)) shall recognize that secondary data arising from peer review publications, together with data from other competent sources (e.g. national government,

official United Nations publications, and publications by United Nations-supported organizations), are preferred over secondary data from other sources.

Note It is intended that a reference to the ILCD as a source of secondary data will be considered in a future revision of this PAS following final agreement of the structure and scope of the ILCD.

7.5 Changes in the life cycle of a product

7.5.1 Temporary unplanned change

Where an unplanned change to the life cycle of a product results in an increase in the assessment of GHG emissions of more than 10% and is experienced for more than three months, a reassessment of the life cycle GHG emissions associated with the product shall be carried out.

7.5.2 Planned change

Where a planned change to the life cycle GHG emissions of a product leads to an increase in the assessment result of 5% or greater for a period exceeding three months, a reassessment of the life cycle GHG emissions associated with the product shall be carried out.

7.6 Variability in emissions arising from the product life cycle

Where the GHG emissions associated with the life cycle of a product vary over time, data shall be collected over a period of time sufficient to establish the average GHG emissions associated with the life cycle of the product.

Where a product is made available on a continuing basis, the assessment of GHG emissions shall cover at least one year. Where a product is differentiated by time (e.g. seasonal products), the assessment of GHG emissions shall cover the particular period associated with the production of the product (see 4.3, 7.2 and 7.5).

Note 1 The average result should be informed by historic data where available.

Note 2 The life cycle GHG emissions of sources of energy, particularly electricity, may vary over time. Where this occurs, data representing the most recent estimate of GHG emissions associated with the energy source should be used.

7.7 Data sampling

Where an input to a process arises from multiple sources and emissions data are collected from a representative sample of the sources used in the



assessment of GHG emissions for a product, the use of sampling shall comply with the requirements for data quality under 7.2.

Note Examples of where data sampling may be appropriate include:

- a) a bank may include data from a representative sample of its branches, rather than from all branches;
- b) a flour mill may include data from a representative sample of grain sources, rather than from all farms that provide it with grain;
- c) where a factory has a number of production lines which produce the same product, it may include data from a representative sample of the production lines.

7.8 Non-CO₂ emissions data for livestock and soils

The estimation of the non-CO₂ GHG emissions arising from livestock, their manure or soils shall use one of the following two approaches with reference to the data quality rules specified in 7.2:

- a) the highest tier approach set out in the IPCC Guidelines for National Greenhouse Gas Inventories (see **Clause 2**); or
- b) the highest tier approach employed by the country in which the emissions were produced.

Note Where organizations implementing this PAS rely on secondary data sources when assessing the GHG emissions arising from agricultural products, they should confirm whether the secondary data source includes emissions arising from direct land use change or whether this needs to be calculated separately.

7.9 Emissions data for fuel, electricity and heat

Fuel and energy data shall include:

- a) the amount of energy used; and
- b) the average emission factor of the energy input (e.g. kgCO₂e/kg fuel, kgCO₂e/MJ electricity or heat) based on the source of energy used.

The emissions associated with fuel and energy used in the life cycle of a product shall be determined in accordance with 6.4.2.

7.9.1 Onsite generation of electricity and heat

Where electricity and/or heat are generated and used onsite, the emission factor for the electricity and/or heat shall be calculated using the method described in this PAS, including emissions from fuel input and upstream emissions.

7.9.2 Offsite generation of electricity and heat

Where electricity and/or heat are generated offsite, the emission factor used shall be either:

- a) for electricity and heat delivered by a stand-alone source (i.e. not part of larger energy transmission system), the emission factor relevant to that source (e.g. for purchases of heat from CHP, the emission factor calculated in accordance with 8.1 and 8.3); or
- b) for electricity and heat delivered via a larger energy transmission system, secondary data that is as specific to the product system as possible (e.g. average electricity supply emission factor for the country in which the electricity is used).



7.9.3 GHG emissions associated with renewable electricity generation

7.9.3.1 Eligibility of renewable energy-specific emission factors

A renewable energy-specific emission factor shall be applied to a process using renewable energy only where both of the following can be demonstrated:

a) the process used the energy (i.e. use of renewable energy generated on-site) or used an equivalent amount of energy of the same type to that generated (i.e. use of renewable energy delivered via an energy transmission network that combines different types of energy generation), and another process did not use the energy generated whilst claiming it as renewable;

and

b) the generation of this renewable energy does not influence the emission factor of any other process or organization using the same type of energy (e.g. renewable electricity).

Where conditions a) or b) are not met, national average energy emission factors for the renewable energy shall be used.

Note 1 Demonstration that the energy is from a renewable source should be carried out independent of other verification or trading schemes.

Note 2 In many situations, the emission factor for renewable energy generation is automatically incorporated into the national average energy emission factor. For example, renewable electricity is typically assumed to be a source of zero-emissions electricity in national reporting of electricity emission factors; were a company to claim a low emission factor for the purchase of renewable electricity (e.g. through the purchase of a "green tariff") that was also included in national reporting, double-counting of the low emissions benefit of the electricity would occur. In some countries (e.g. the UK), methods for reporting the impact of renewable electricity generation on the national emissions factor for electricity are not sufficiently developed to separately account for grid-average and tariff-specific electricity supplies.

Note 3 In countries where the flow of renewable electricity is accurately accounted for, the requirement of 7.9.3.2 will allow companies that are using renewable electricity, or purchasing renewable electricity through a dedicated tariff, to use the GHG emission of the renewable electricity (rather than grid average carbon intensity) when calculating the emissions arising from their processes.

7.9.3.2 Emissions from renewable electricity

The assessment of emissions from renewable electricity generation shall include those emissions arising within the system boundary specified in 6.4.2 (e.g. where

renewable electricity is generated from biomass, the emissions associated with the electricity generation shall include emissions associated with the direct land use change, growing, harvesting, processing, transporting, etc. of the biomass as applicable).

7.9.4 Emissions from biomass and biofuels

Emissions arising from the use of biomass (e.g. co-firing of biomass, biodiesel, bioethanol) shall include the GHG emissions arising from the production of the fuel, and shall exclude the CO₂ emissions arising from the biogenic carbon component of the fuel.

Note 1 Where biofuel is produced from waste (e.g. cooking oil after it has been used in a cooking process), the GHG emissions arising from the production of the fuel are those arising from the conversion of the waste to fuel.

Note 2 Where the biofuel is not produced from waste (e.g. biodiesel produced from oilseed rape or palm oil, ethanol produced from wheat, sugar beet, sugarcane or corn), the GHG emissions associated with the use of the biofuel include the emission sources occurring within the boundaries of the life cycle of the biofuel.

7.10 Validity of analysis

Results obtained from the implementation of this PAS shall be valid for a maximum period of two years, unless there is a change in the life cycle of the product whose GHG emissions are being assessed (see 7.5), in which situation, the validity ceases.

Note The length of time that an analysis is valid will vary depending on the characteristics of the life cycle of the product.

7.11 Disclosure

7.11.1 System boundary

Where use phase emissions form part of an assessment carried out under this PAS that is communicated to a third party (e.g. consumers), a description of the system boundary that has been used for the assessment of the GHG emissions of a product shall also be made available. This description shall include decisions taken regarding the system boundary and the use of a PCR as the basis of the system boundary (if applicable).

The description of the system boundary shall be made available at, or prior to, the communication of the assessment of the life cycle GHG emissions of such a product.

7.11.2 Use phase analysis

Where use phase emissions form part of an assessment carried out under this PAS that is communicated to a

third party (e.g. consumers), a description of the use profile shall also be made available. The use profile shall be made available at, or prior to, the communication of the use phase emissions to a third party.

Note The use profile does not have to be made available in the same place as the communication of the results of the assessment. However, it should be made available in a readily accessible location (e.g. website).

7.11.3 Carbon storage assessment

Where an assessment of the life cycle GHG emissions of a product that includes an assessment of the impact of carbon storage is communicated to a third party (e.g. consumers), a full description of the basis on which the impact of the carbon storage was calculated, including the emissions profile of the product, shall be made available.

The basis for the calculation of the impact of carbon storage shall be made available at, or prior to, the

communication of the assessment of the life cycle GHG emissions of such a product.

Note Disclosure of the basis of the use phase calculation or carbon storage assessment does not have to occur at the same location, or in the same form, as communication of the use phase emissions to a third party occurs. For example, the basis of the use phase calculation or carbon storage assessment may be made available via a web site.

7.11.4 Secondary data sources

Where secondary data are used in the application of this PAS, a description of the source of the secondary data shall also be made available. The description of the secondary data source shall be made available at, or prior to, the communication of the assessment of the life cycle GHG emissions of the product.

Note The description of the secondary data source does not have to be made available in the same place as the communication of the results of the assessment. For example, the basis of the use phase calculation or carbon storage assessment can be made available via a web site.



8 Allocation of emissions

8.1 General requirement

Unless otherwise stated in this PAS, the approach to allocation shall be as described in **8.1.1**.

8.1.1 Allocation to co-products

The preferred approach to allocation of emissions to co-products shall be, in order of preference:

- a) dividing the unit processes to be allocated into two or more sub-processes and collecting the input and output data related to these sub-processes; or
- b) expanding the product system to include additional functions related to the co-products where:
 - i) a product which is displaced by one or more of the co-products of the process being considered can be identified; and
 - ii) the avoided GHG emissions associated with the displaced product represent the average emissions arising from the provision of the avoided product.

Note 1 For example, where a process results in the co-production of electricity that is exported to a larger electricity transmission system, the avoided emissions resulting from this co-production of electricity would be based on the average GHG emissions intensity of grid electricity.

Note 2 See BS EN ISO 14044:2006, 4.3.4.2(a).

Where it can be demonstrated that neither of these approaches is practicable, the GHG emissions arising from the process shall be allocated between the co-products in proportion to the economic value of the co-products (i.e. economic allocation).

8.1.2 Recording allocation assumptions

The approach to the allocation of emissions to co-product shall be recorded by the organization implementing this PAS. Where the allocation to co-products is carried out by expanding the product system (see **8.1.1 (b)**), the organization implementing this PAS shall record the assumptions made regarding the scope and emissions of the expanded product system.

8.2 Emissions from waste

Where waste results in GHG emissions (e.g. organic matter disposed of in a landfill), emissions from the waste shall be treated as follows:

8.2.1 CO₂ emissions from waste

Where CO₂ emissions arise from the biogenic carbon

fraction of the waste, these emissions shall be assigned a GWP of zero.

Where CO₂ emissions arise from the fossil carbon fraction of the waste, these emissions shall be assigned a GWP of 1 and shall be included in the life cycle GHG emissions of the product that gave rise to the waste.

8.2.2 Non-CO₂ emissions from waste

Where non-CO₂ emissions arise from the biogenic and fossil carbon fraction of the waste, these emissions shall be assigned the appropriate GWP given in Annex A and shall be included in the life cycle GHG emissions of the product that gave rise to the waste.

8.2.3 Combustion of methane emissions from waste

8.2.3.1 Methane combustion with energy recovery

Where methane from waste is combusted to generate useful energy:

- a) No GHG emissions shall be incurred where the methane being combusted is derived from the biogenic component of the waste;
- b) GHG emissions shall be assigned to the useful energy produced where the methane being combusted is derived from the fossil component of the waste.

Note See 8.3 for the treatment of emissions from CHP.

8.2.3.2 Methane combustion without energy recovery

Where methane is combusted without the generation of useful energy (i.e. flaring):

- a) No GHG emissions shall be incurred where the methane being combusted is derived from the biogenic component of the waste;
- b) GHG emissions shall be assigned to the life cycle of the product that gave rise to the waste when the methane being combusted is derived from the fossil component of the waste.

8.3 Emissions from energy (CHP emissions)

Where energy production from CHP is exported to a larger system (e.g. export of electricity to a national electricity network), the avoided GHG emissions arising from the exported energy shall be assessed in accordance with **8.1.1**.

Where some or all of the heat and electricity production from CHP is used by more than one process, the emissions arising from CHP, less any avoided burden calculated in **8.1.1**, shall be allocated between the heat and electricity used. The allocation shall be

carried out in proportion to the amount of useful energy delivered in each form, multiplied by the intensity of GHG emissions associated with each unit of useful energy delivered as heat and electricity. The intensity of GHG emissions shall be:

- a) for boiler-based CHP systems (e.g. coal, wood, solid fuel) – emissions per MJ electricity:emissions per MJ heat in the ratio of 2.5:1;
- b) for turbine-based CHP systems (e.g. natural gas, landfill gas) – emissions per MJ electricity:emissions per MJ heat in the ratio of 2.0:1.

Note The allocation of emissions to heat and electricity arising from CHP relies on the process-specific ratio of heat to electricity arising from each CHP system. For example, where a boiler-based CHP system delivers useful energy in the electricity:heat ratio of 1:6, 2.5 units of emissions would be allocated to each unit of electricity, and 1 unit of emissions would be allocated to each unit of heat delivered by the CHP system. In this example, while the CHP system had a useful electricity:heat ratio of 1:6, the corresponding GHG emissions ratio was 2.5:6. These results will change with different heat:electricity characteristics of the CHP system.

8.4 Emissions from transport

Where more than one product is being transported by a transport system (e.g. a truck, ship, aircraft, train), the emissions arising from the transport system shall be divided amongst the products on the basis of:

- a) where mass is the limiting factor for the transport system: the relative mass of the different products being transported; or
- b) where volume is the limiting factor for the transport system: the relative volume of the different products being transported.

Transport emissions shall include the emissions associated with the return journey of a vehicle where the vehicle does not transport products on its return, or for that proportion of the return journey where the vehicle does not transport products.

8.5 Use of recycled material and recycling

The method for assessing emissions arising from recycled material shall be as specified in **Annex D**.

8.6 Treatment of emissions associated with reuse and remanufacture

Where a product is reused, the GHG emissions of the product shall be determined as follows:

- a) The life cycle GHG emissions, excluding use phase emissions, shall be determined;
- b) The emissions calculated in a) shall be divided by the anticipated number of times the product is re-used;
- c) Any emissions associated with remanufacturing the product to make it suitable for reuse shall be included in the assessment.

The emissions per use or reuse shall be the sum of emissions calculated in b), plus any emissions arising from the use phase and remanufacturing for each use or reuse.



9 Calculation of the GHG emissions of products

The following method shall be used to calculate the GHG emissions for a functional unit:

1. Primary activity data and secondary data shall be converted to GHG emissions by multiplying the activity data by the emission factor for the activity. This shall be recorded as GHG emissions per functional unit of product.
2. GHG emissions data shall be converted into CO₂e emissions by multiplying the individual GHG emissions figures by the relevant GWP. The impact of any delay in the release of emissions, calculated in accordance with 5.2, shall be included in this step.
3. The impact of carbon storage associated with the product and calculated in accordance with 5.4 shall be expressed as CO₂e and deducted from the total calculated at step 2 above.
4. The results shall be added together to obtain GHG emissions in terms of CO₂e emissions per functional unit. When the result is calculated, the result shall be:
 - a) business-to-consumer: the complete product life cycle GHG emissions arising from the product (including the use phase), and separately the use phase GHG emissions arising from the product; or
 - b) business-to-business: the GHG emissions that have occurred up to, and including, the point where the input arrives at a new organization, including all upstream emissions.
5. The GHG emissions shall then be scaled to account for any minor raw materials or activities that were excluded from the analysis by dividing the estimated emissions by the proportion of emissions calculated for the anticipated life cycle GHG emissions.



10 Claims of conformity

10.1 General

Claims of conformance with this PAS shall be made in the principal documentation or on the packaging provided for the product for which the claim is being made, in accordance with BS EN ISO/IEC 17050-1 and in the form relevant to that particular claim as provided for in 10.4. This statement shall include unambiguous identification of the organization claiming conformance.

Note In accordance with the relevant definitions given in BS EN ISO/IEC 17000, the term “certified” is used in this PAS to describe the issuing of an attestation document by an accredited independent third party certification body. The term “declared”, appropriately qualified, is used to identify the other options accepted in this PAS.

10.2 Scope of claim

In making a claim of conformance with this PAS, the organization shall address all of the provisions of the PAS.

10.3 Basis of claim

10.3.1 General

The claim shall identify the type of conformity assessment undertaken as one of:

- a) independent third party certification in accordance with 10.3.2;
- b) other party verification in accordance with 10.3.3; or
- c) self verification in accordance with 10.3.4.

Note Attention is drawn to the fact that claims of conformity used to support communication of results calculated under this PAS to third parties, made in accordance with 10.3.2, are most likely to gain consumers' confidence.

10.3.2 Independent third party certification

Organizations seeking to demonstrate that their calculations of GHG emissions have been independently verified as being in accordance with this PAS, shall undergo assessment by an independent third party certification body accredited to provide assessment and certification to this PAS.

10.3.3 Other party verification

Organizations using an alternative method of verification involving parties other than those qualifying as accredited independent third parties, shall satisfy themselves that any such party is able to

demonstrate compliance with recognized standards setting out requirements for certification bodies.

Note Examples of such recognized standards include BS EN ISO/IEC 17021 and BS EN 45011.

10.3.4 Self verification

In undertaking self verification, organizations shall be able to demonstrate that the calculations have been made in accordance with this PAS, and make supporting documentation available to any interested party. The appropriate method for self verification and for presentation of the results shall be through the application of BS EN ISO 14021.

Note Organizations for whom neither independent third party certification nor other party verification is a realistic option, may rely on self verification. In so doing, organizations should be aware that external verification could be required in the event of challenge and that consumers could have less confidence in this option.

10.4 Identification of the basis of a claim

All claims of conformity with this PAS shall include identification of the basis of the claim, using the appropriate form of disclosure, as follows:

1. For claims of conformity based on certification in accordance with 10.3.2:

“Greenhouse gas emission calculated by [insert unambiguous identification of the claimant] in accordance with PAS 2050, [insert unambiguous identification of the certifying body] certified.”
2. For claims of conformity based on other party assessment in accordance with 10.3.3:

“Greenhouse gas emission calculated by [insert unambiguous identification of the claimant] in accordance with PAS 2050, [insert unambiguous identification of the validating body] declared.”
3. For claims of conformity based on self verification in accordance with 10.3.4:

“Greenhouse gas emission calculated by [insert unambiguous identification of the claimant] in accordance with PAS 2050, self declared.”

Annex A

Global warming potential (normative)

The values of global warming potentials for GHGs to be used in calculations shall be in accordance with **Table A.1** (IPCC 2007, Table 2.14, see **Clause 2**).

Note Attention is drawn to the requirement that the GWP actually used in calculations is the latest available from the

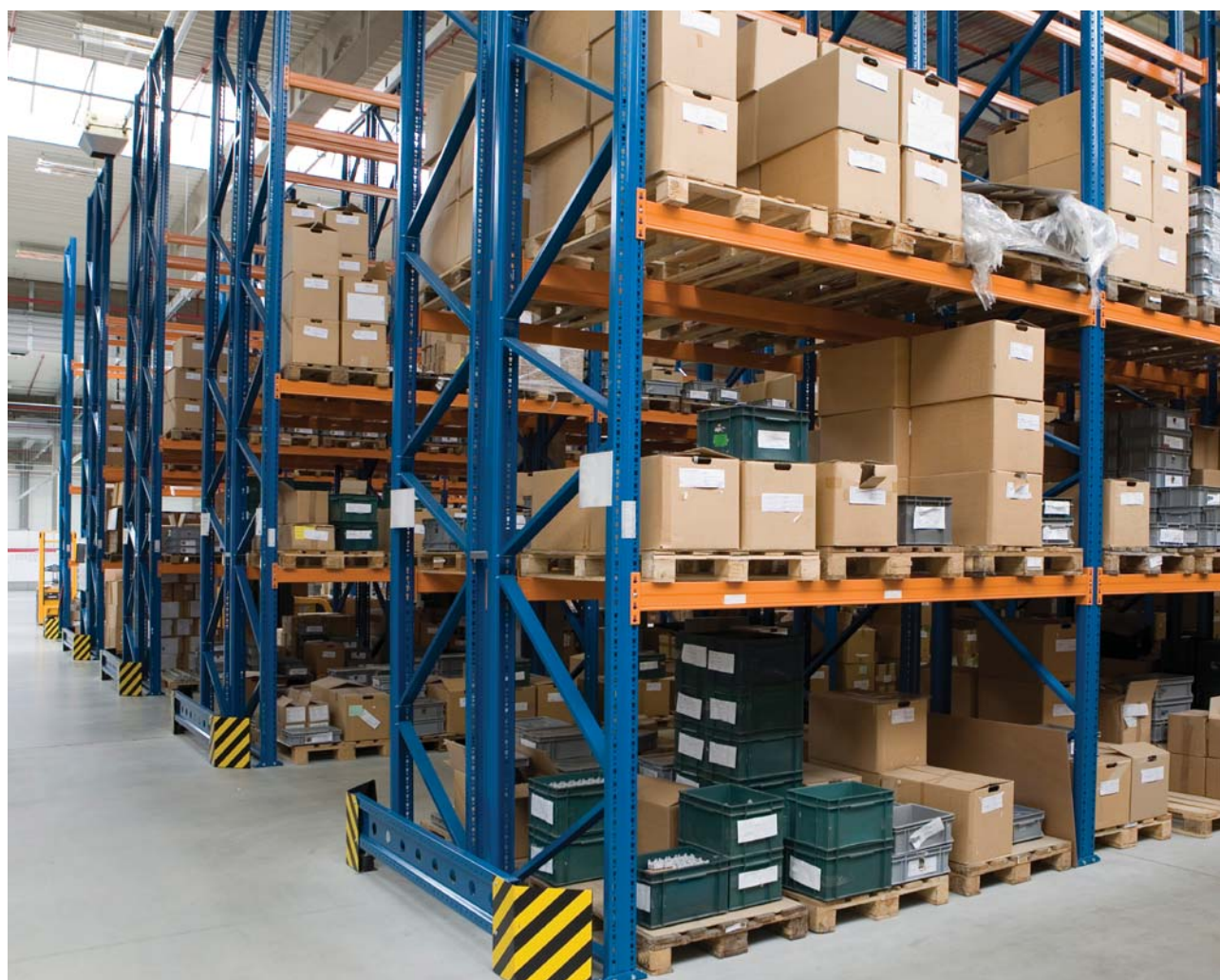
IPCC (see 5.1.1). It is the responsibility of the organization undertaking GHG emissions assessment to confirm the currency of GWP values given in **Table A.1** before using them.

Table A.1 Direct (except for CH₄) global warming potentials (GWP) relative to CO₂

Industrial designation or common name	Chemical formula	GWP for 100-year time horizon (at date of publication)
Carbon dioxide	CO ₂	1
Methane ^c	CH ₄	25
Nitrous oxide	N ₂ O	298
<i>Substances controlled by the Montreal Protocol</i>		
CFC-11	CCl ₃ F	4,750
CFC-12	CCl ₂ F ₂	10,900
CFC-13	CClF ₃	14,400
CFC-113	CCl ₂ FCClF ₂	6,130
CFC-114	CClF ₂ CClF ₂	10,000
CFC-115	CClF ₂ CF ₃	7,370
Halon-1301	CBrF ₃	7,140
Halon-1211	CBrClF ₂	1,890
Halon-2402	CBrF ₂ CBrF ₂	1,640
Carbon tetrachloride	CCl ₄	1,400
Methyl bromide	CH ₃ Br	5
Methyl chloroform	CH ₃ CCl ₃	146
HCFC-22	CHClF ₂	1,810
HCFC-123	CHCl ₂ CF ₃	77
HCFC-124	CHClF ₂ CF ₃	609
HCFC-141b	CH ₃ CCl ₂ F	725
HCFC-142b	CH ₃ CClF ₂	2,310
HCFC-225ca	CHCl ₂ CF ₂ CF ₃	122
HCFC-225cb	CHClF ₂ CClF ₂	595

Industrial designation or common name	Chemical formula	GWP for 100-year time horizon (at date of publication)
<i>Hydrofluorocarbons</i>		
HFC-23	CHF ₃	14,800
HFC-32	CH ₂ F ₂	675
HFC-125	CHF ₂ CF ₃	3,500
HFC-134a	CH ₂ FCF ₃	1,430
HFC-143a	CH ₃ CF ₃	4,470
HFC-152a	CH ₃ CHF ₂	124
HFC-227ea	CF ₃ CHFCF ₃	3,220
HFC-236fa	CF ₃ CH ₂ CF ₃	9,810
HFC-245fa	CHF ₂ CH ₂ CF ₃	1,030
HFC-365mfc	CH ₃ CF ₂ CH ₂ CF ₃	794
HFC-43-10mee	CF ₃ CHFCHFCF ₂ CF ₃	1,640
<i>Perfluorinated compounds</i>		
Sulfur hexafluoride	SF ₆	22,800
Nitrogen trifluoride	NF ₃	17,200
PFC-14	CF ₄	7,390
PFC-116	C ₂ F ₆	12,200
PFC-218	C ₃ F ₈	8,830
PFC-318	C-C ₄ F ₈	10,300
PFC-3-1-10	C ₄ F ₁₀	8,860
PFC-4-1-12	C ₅ F ₁₂	9,160
PFC-5-1-14	C ₆ F ₁₄	9,300
PFC-9-1-18	C ₁₀ F ₁₈	>7,500
Trifluoromethyl sulfur pentafluoride	SF ₅ CF ₃	17,700
<i>Fluorinated ethers</i>		
HFE-125	CHF ₂ OCF ₃	14,900
HFE-134	CHF ₂ OCHF ₂	6,320
HFE-143a	CH ₃ OCF ₃	756
HCFE-235da2	CHF ₂ OCHClCF ₃	350
HFE-245cb2	CH ₃ OCF ₂ CHF ₂	708
HFE-245fa2	CHF ₂ OCH ₂ CF ₃	659
HFE-254cb2	CH ₃ OCF ₂ CHF ₂	359
HFE-347mcc3	CH ₃ OCF ₂ CF ₂ CF ₃	575
HFE-347pcf2	CHF ₂ CF ₂ OCH ₂ CF ₃	580
HFE-356pcc3	CH ₃ OCF ₂ CF ₂ CHF ₂	110

Industrial designation or common name	Chemical formula	GWP for 100-year time horizon (at date of publication)
HFE-449sl (HFE-7100)	$C_4F_9OCH_3$	297
HFE-569sf2 (HFE-7200)	$C_4F_9OC_2H_5$	59
HFE-43-10-pccc124 (H-Galden 1040x)	$CHF_2OCF_2OC_2F_4OCHF_2$	1,870
HFE-236ca12 (HG-10)	$CH_2OCF_2OCHF_2$	2,800
HFE-338pcc13 (HG-01)	$CHF_2OCF_2CF_2OCHF_2$	1,500
<i>Perfluoropolyethers</i>		
PFPME	$CF_3OCF(CF_3)CF_2OCF_2OCF_3$	10,300
<i>Hydrocarbons and other compounds – direct effects</i>		
Dimethylether	CH_3OCH_3	1
Methylene chloride	CH_2Cl_2	8.7
Methyl chloride	CH_3Cl	13



Annex B

Calculation of the weighted average impact of emissions arising from the use phase and final disposal phase of products (normative)

B.1 General

Where emissions arising from the use phase of a product, or from its final disposal, occur after the first year following the formation of the product but within the 100-year assessment period, the impact of these emissions shall reflect the weighted average time the emissions are present in the atmosphere during the 100-year assessment period.

Note 1 The formulae presented in this Annex represent a simplification of the approach outlined in Table 2.14 (footnote (a)), Chapter 2 of IPCC 2007 (see Clause 2). Full implementation of the IPCC approach will result in a more precise result.

Note 2 The approach presented in Table 2.14 (footnote (a)), Chapter 2 of IPCC 2007 (see Clause 2) is applicable to CO₂ emissions only, while the approximation presented here is applied to GWP data assessed under this PAS. As a result, the approximation will be less accurate where the overall CO₂e emissions of the product include a significant non-CO₂ component.



B.1.1 Specific case: delayed single release

Where emissions from the use phase or the final disposal phase of a product occur as a single release within 25 years of the formation of the product, the weighting factor to be applied to the GHG emissions released at that time shall reflect the number of years of delay in the emissions being released (i.e. the number of years between formation of the product and the single release of the emissions) according to:

$$\text{Weighting factor} = \frac{100 - (0.76 \times t_o)}{100}$$

where

t_o = the number of years between formation of the product and the single release of the emissions.

B.1.2 General case: delayed release

In cases not covered in B.1.1, the weighting factor to be applied to the GHG emissions released in the atmosphere shall be calculated according to:

$$\text{Weighting factor} = \frac{\sum_{i=1}^{100} x_i \cdot (100 - i)}{100}$$

where

i = each year in which emissions occur,

x = the proportion of total emissions occurring in any year i .

Note For example, if use phase emissions were to be delayed for 10 years following formation of the product, with total emissions being released evenly over the following five years, then the weighting factor that represents the weighted average time these emissions are present in the atmosphere would be:

$$\frac{(0.2 \times (100 - 11)) + (0.2 \times (100 - 12)) + (0.2 \times (100 - 13)) + (0.2 \times (100 - 14)) + (0.2 \times (100 - 15))}{100} = 0.87$$

In this example, the total amount of use phase emissions, expressed as CO₂e, released during the 100-year assessment period, would be multiplied by a factor of 0.87 to reflect the weighted average time these emissions are present in the atmosphere during the 100-year assessment period.

Annex C

Calculation of the weighted average impact of carbon storage in products (normative)

C.1 General

Where carbon storage, or the uptake of atmospheric carbon, over the life cycle of the product occur within the 100-year assessment period, the impact of this storage or uptake emissions shall reflect the weighted average time of storage during the 100-year assessment period.

C.1.1 Specific case: biogenic carbon storage following product formation

Where the full carbon storage benefit of a product exists for between 2 and 25 years after the formation of the product (and no carbon storage benefit exists after that time), the weighting factor to be applied to the CO₂ storage benefit over the 100-year assessment period shall be calculated according to:

$$\text{Weighting factor} = \frac{(0.76 \times t_o)}{100}$$

where

t_o = the number of years the full carbon storage benefit of a product exists following the formation of the product.

C.1.2 General case: biogenic carbon storage or atmospheric carbon take-up

In cases not covered in C.1.1, the weighting factor to be applied to the CO₂ storage benefit over the 100-year assessment period shall be calculated according to:

$$\text{Weighting factor} = \frac{\sum_{i=1}^{100} X_i}{100}$$

where

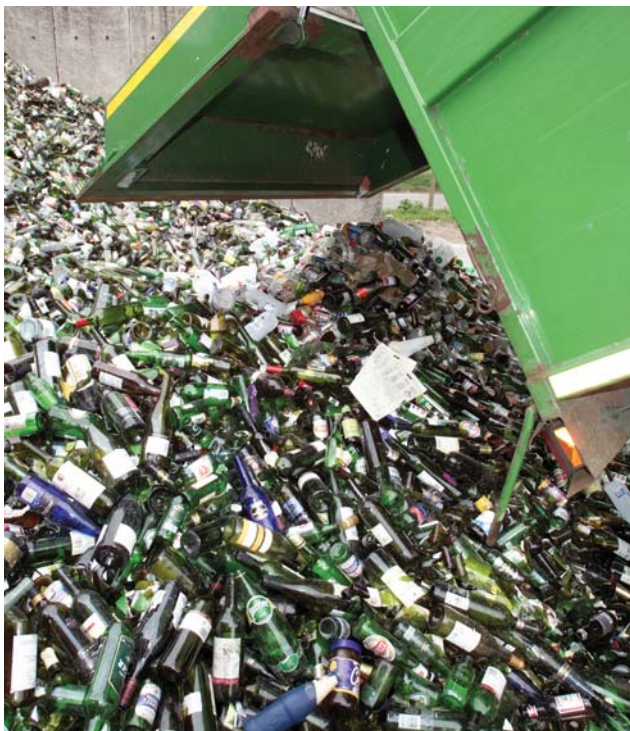
i = each year in which storage occurs,

x = the proportion of total storage remaining in any year i .

Note For example, if a product were to store biogenic carbon over a period of five years following formation of the product, and the amount of carbon stored were to then decrease evenly across the following five years, the weighting factor that represents the weighted average time of carbon storage in the product would be:

$$\frac{(1 + 1 + 1 + 1 + 1 + 0.8 + 0.6 + 0.4 + 0.2 + 0)}{100} = 0.07$$

In this example, 100% of the carbon storage benefit occurs over the first five years; this then decreases 20% (0.2) per year over the next five years. Therefore, the total amount of biogenic carbon, expressed as CO₂e, stored in the product would be multiplied by a factor of 0.07 to reflect the weighted average impact of biogenic carbon stored in this product over the 100-year assessment period.



Annex D

Calculation of emissions arising from recyclable material inputs

(normative)

D.1 Recycled content originating from the same product system

Where the life cycle of a product includes a material input with recycled content originating from the same product system, the emissions arising from that material shall reflect the product specific recycle content and/or recycling rate based on the calculation given below.



$$\text{Emissions / unit} = (1 - R_1) \times E_V + (R_1 \times E_R) + (1 - R_2) \times E_D$$

where

R_1 = proportion of recycled material input,

R_2 = proportion of material in the product that is recycled at end-of-life,

E_R = emissions arising from recycled material input, per unit of material,

E_V = emissions arising from virgin material input, per unit of material,

E_D = emissions arising from disposal of waste material, per unit of material

D.1.1 Material input with system average recycle content and recycling rate

Where the life cycle of a product includes a material input that contains the system average proportion of recycled content and is recycled at the system average recycling rate for that product category, the calculation in D.1 shall reflect the system average recycle content and recycle rate.

Note It is assumed that materials are recycled in a steady-state system. This may not be the case for some materials where the total stock of material in use is increasing or decreasing over time.

D.1.2 Material input with a product specific recycle content and/or recycling rate

Where the life cycle of a product includes a material input with a specified proportion of recycled content and/or the material in the product has a recycle rate that is different from the average recycle rate for that product category, the emissions arising from that material shall reflect the product specific recycle content and/or recycling rate.

D.1.3 Demonstration of product specific recycle content and/or recycling rate

Where emissions associated with product specific recycled content and/or recycling rate are determined in accordance with D.1, the organization implementing this PAS shall record the product specific recycle content and/or recycling rate.

D.2 Other types of recycling

Where the life cycle of a product includes a material input with recycled content other than that described in D.1, the emissions arising from this material shall be assessed using an approach consistent with BS EN ISO 14044:2006, 4.3.4.3.

Note The treatment of recycling will be given further consideration in future revisions of this PAS.

D.3 Recording the basis of the treatment of recycling

Where the assessment of the life cycle GHG emissions of a product includes emissions arising from the recycling of material, the approach adopted in assessing the GHG emissions associated with recycling shall be recorded and retained (see 4.4).



Annex E

Default land use change values for selected countries (normative)

GHG emissions arising from specified changes in land use for a selection of countries shall be as given in **Table E.1**.

Note 1 The information in **Table E.1** is derived from the Office of the Renewable Fuels Agency's technical guidance [5].

Note 2 See 5.5.1 for determining the GHG emissions associated with land use change where there is limited knowledge regarding the location or type of land use change.

Note 3 For emissions from land use change in countries not listed in this Annex, refer to IPCC Guidelines for National Greenhouse Gas Inventories (see **Clause 2**), with particular reference to Chapter 5, Section 3 of IPCC 2006 Guidelines for National Greenhouse Gas Inventories which provides details on how to apply the standard methodology to calculate the carbon lost when land is converted to cropland.

Table E.1 Default land use change values for selected countries

Country	Current land use	Previous land use	GHG emissions (t CO ₂ e / ha/yr)
Argentina	Annual cropland	Forest land	17
		Grassland	2.2
	Perennial cropland	Forest land	15
		Grassland	1.9
Australia	Annual cropland	Forest land	23
		Grassland	2.2
	Perennial cropland	Forest land	21
		Grassland	1.9
Brazil	Annual cropland	Forest land	37
		Grassland	10.3
	Perennial cropland	Forest land	26
		Grassland	8.5
Canada	Annual cropland	Forest land	17
		Grassland	2.2
	Perennial cropland	Forest land	16
		Grassland	1.9
Finland	Annual cropland	Forest land	15
		Grassland	7.3
	Perennial cropland	Forest land	14
		Grassland	6.9
France	Annual cropland	Forest land	18
		Grassland	4.5
	Perennial cropland	Forest land	14
		Grassland	4.2

Country	Current land use	Previous land use	GHG emissions (t CO ₂ e / ha/yr)
Germany	Annual cropland	Forest land	21
		Grassland	7.0
	Perennial cropland	Forest land	14
		Grassland	6.7
Indonesia	Annual cropland	Forest land	33
		Grassland	19.5
	Perennial cropland	Forest land	31
		Grassland	17.7
Malaysia	Annual cropland	Forest land	37
		Grassland	10.3
	Perennial cropland	Forest land	26
		Grassland	8.5
Mozambique	Annual cropland	Forest land	24
		Grassland	3.6
	Perennial cropland	Forest land	22
		Grassland	3.2
Pakistan	Annual cropland	Forest land	16
		Grassland	3.6
	Perennial cropland	Forest land	15
		Grassland	3.2
Poland	Annual cropland	Forest land	21
		Grassland	7.0
	Perennial cropland	Forest land	14
		Grassland	6.7
South Africa	Annual cropland	Forest land	26
		Grassland	1.6
	Perennial cropland	Forest land	25
		Grassland	1.2
Ukraine	Annual cropland	Forest land	18
		Grassland	6.2
	Perennial cropland	Forest land	18
		Grassland	5.8
United Kingdom	Annual cropland	Forest land	27
		Grassland	7.0
	Perennial cropland	Forest land	20
		Grassland	6.7
United States	Annual cropland	Forest land	17
		Grassland	1.9
	Perennial cropland	Forest land	16
		Grassland	1.5

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