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Stationary source emissions — Determination of greenhouse gas emissions in energy-intensive industries —

Part 1: General aspects

Émissions de sources fixes — Détermination des émissions de gaz à effet de serre dans les industries énergo-intensives —

Partie 1: Aspects généraux

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee Technical Committee ISO/TC 207, *Environmental management*, Subcommittee SC 7, *Greenhouse gas management and related activities*.

A list of all parts in the ISO 19694 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document is the first part of ISO 19694 series, which contains harmonized common methods for measuring, testing and quantifying greenhouse gas (GHG) emissions from six sector-specific industry sectors, and one document on general aspects.

In particular, the ISO 19694 series contains harmonized methods for:

a) measuring, testing and quantifying GHG emissions from sector-specific sources;

b) assessing the level of GHG emissions performance of production processes over time, at production sites;

c) establishing and providing reliable, accurate and quality information for reporting purposes.

This document is harmonized with ISO 14064-1, which contains broader requirements. This document deals with the general aspects and can serve as a basis for any specific sector standards.

The ISO 19694 series enables industry to manage the GHG emissions output of the production processes and to allow performance assessment between plants and over time. The objective is to continuously improve the reduction potential of the production processes by acting on the emission performance over time.

This document contributes to competitiveness of industry and is a tool for formalizing businesses' contributions to providing emission reductions in their operations and to developing low-carbon technology solutions to the market.

This document also addresses the following issues:

— avoidance of double-counting at plant, organization, group, national and international levels;

— distinguishing different drivers of emissions (technological improvement, internal and external growth);

— reporting of emissions in absolute as well as specific (unit-based) terms;

— ensuring that the full range of achieved direct and indirect GHG abatements are reflected.

This document also provides a flexible tool to support the needs of different monitoring and reporting purposes, such as internal management and public corporate reporting of GHG emission performance in accordance with the production processes on a production site.

The purpose of this document is not to prescribe specific requirements for verification or certification of methods, measurements, calculations or resulting data, which are given in ISO 14064-3.

Due to the nature of the issues concerned, and their wide public interest, verification and certification should be prepared for. The operator should organize files and records in such a way that they are easily retrievable and traceable. Documentation includes:

— personnel qualifications;

— methods applied;

— time series of measurements performed;

— calibration status of equipment used;

— calculations of emissions.

The ISO 19694 series should be readily available for corporate internal verification, second-party (i.e. customer) verification or third-party certification if required by interested parties.

Within this document, “measuring, testing and quantifying for GHG emissions” is understood to be the emissions inventory of a site (plant, facility), including energy flows and material flows leaving or entering the system boundaries. Typically, inventory data are absolute data. Inventory data should represent the original data set without any corrections, adaptations, etc. (e.g. with regard to other energy indirect GHG emissions).

Performance assessment depends on the sector-specific conditions. Performance assessment may be based on absolute and/or (product-) specific data and may apply corrections or adaptations in order to allow a fair and transparent comparison of plants.

This document is not appropriate for use for life cycle analysis and product carbon footprint.

Stationary source emissions — Determination of greenhouse gas emissions in energy-intensive industries —

Part 1: General aspects

1 Scope

This document specifies principles and requirements for the determination of greenhouse gas (GHG) emissions from sector-specific sources such as from steel and iron, cement, aluminium, lime and ferroalloy-producing industries.

This document specifies definitions and requirements valid to the sector-specific parts of ISO 19694 series. It provides common methodological issues and defines the details for applying the requirements for the harmonized methods, which include:

a) measuring, testing and quantifying methods for GHG emissions of the above-mentioned sector-specific sources in the cited standards;

b) assessing the level of GHG emissions performance of production processes over time at production sites;

c) establishing and providing reliable, accurate and quality information for reporting and verification purposes.

The application of this document to the other sector-specific standards in the ISO 19694 series ensures accuracy, precision and reproducibility of the obtained results. For this reason, it is a generic standard.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14064-1:2018, *Greenhouse gases — Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals*

ISO 14956, *Air quality — Evaluation of the suitability of a measurement procedure by comparison with a required measurement uncertainty*

ISO 16911-1, *Stationary source emissions — Manual and automatic determination of velocity and volume flow rate in ducts — Part 1: Manual reference method*

ISO 16911-2, *Stationary source emissions — Manual and automatic determination of velocity and volume flow rate in ducts — Part 2: Automated measuring systems*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
absolute greenhouse gas emission
absolute GHG emission
GHG emissions (3.17) expressed as a mass stream

Note 1 to entry: It is expressed in tonnes of *carbon dioxide equivalent* (3.7) per year (tCO_2e/year).

3.2
alternative fuel
fuel materials or products used as a source of thermal energy and not classified as *traditional fuel* (3.43)

Note 1 to entry: In some industries, wastes such as plastics, solvents, waste oil, end-of-life tyres, etc. and different types of mixed or pure *biomass* (3.6) fuels are used as alternative fuel.

3.3
base year
specific, historical period identified for the purpose of comparing *GHG emissions* (3.17) or GHG removals or other GHG-related information over time

[SOURCE: ISO 14064-1:2018, 3.2.10]

3.4
biogenic carbon
carbon derived from *biomass* (3.6)

[SOURCE: ISO 14067:2018, 3.1.7.2]

3.5
biogenic carbon dioxide
biogenic CO_2
CO_2 obtained by the oxidation of *biogenic carbon* (3.4)

3.6
biomass
material of biological origin, excluding material embedded in geological formations and material transformed to fossilized material

Note 1 to entry: Biomass includes organic material (both living and dead), e.g. trees, crops, grasses, tree litter, algae, animals, manure and waste of biological origin.

Note 2 to entry: In this document, biomass excludes peat.

[SOURCE: ISO 14067:2018, 3.1.7.1]

3.7
carbon dioxide equivalent
CO_2e
unit for comparing the radiative forcing of a *GHG* (3.15) to that of carbon dioxide

Note 1 to entry: The carbon dioxide equivalent is calculated using the mass of a given GHG multiplied by its *global warming potential* (3.14).

[SOURCE: ISO 14064-1:2018, 3.1.13]

3.8
direct greenhouse gas emission
direct GHG emission
emission from *GHG sources* (3.20) owned or controlled by the reporting *organization* (3.32)

Note 1 to entry: This document uses the concepts of *equity share* (3.10) or *financial control* (3.12) or *operational control* (3.31) to establish *organizational boundaries* (3.33).

3.9
emissions report
stand-alone document intended to communicate an *organization's* (3.32) information related to *GHG* (3.15) and energy, including the results of its performance assessment

3.10
equity share
percentage of economic interest in, or benefit derived from, a *facility* (3.11)

Note 1 to entry: Under this approach, an *organization* (3.32) (corporation, group) or a company consolidates its *GHG emissions* (3.17) in accordance with the (pro rata) equity share it holds in each operation, i.e. in accordance with ownership. As an exception, no emissions are consolidated for so-called fixed asset investments where a company owns only a small part of the total shares of an operation and exerts neither significant influence nor *financial control* (3.12). Other possible exceptions relate to the economic substance of a relationship.

3.11
facility
single installation, set of installations or production *processes* (3.35) (stationary or mobile), which can be defined within a single geographical boundary, organizational unit or production process

[SOURCE: ISO 14064-1:2018, 3.4.1]

3.12
financial control
ability of an *organization* (3.32) to direct the financial and operating policies of an operation with a view to gaining economic benefits from its activities

Note 1 to entry: The financial control usually exists if the organization has the right to the majority benefits of the operation, or if it retains the majority risks and rewards of ownership of the operation's assets. Under this approach, companies consolidate 100 % of the emissions of those operations over which they have financial control. As an exception, consolidation in accordance with *equity share* (3.10) is required for joint ventures where partners have joint financial control.

3.13
fossil carbon
carbon that is contained in fossilized material

Note 1 to entry: Examples of fossilized material are coal, oil and natural gas and peat.

[SOURCE: ISO 14067:2018, 3.1.7.3]

3.14
global warming potential
GWP
index, based on radiative properties of *GHGs* (3.15), measuring the radiative forcing following a pulse emission of a unit mass of a given GHG in the present-day atmosphere integrated over a chosen time horizon, relative to that of carbon dioxide (CO_2)

[SOURCE: ISO 14064-1:2018, 3.1.12]

3.15
greenhouse gas
GHG
gaseous constituent of the atmosphere, both natural and anthropogenic, that absorbs and emits radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere and clouds

Note 1 to entry: For list of GHGs, see the latest Intergovernmental Panel on Climate Change (IPCC) Assessment Report[22].

Note 2 to entry: Water vapour and ozone are anthropogenic as well as natural GHGs, but are not included as recognized GHGs due to difficulties, in most cases, in isolating the human-induced component of global warming attributable to their presence in the atmosphere.

[SOURCE: ISO 14064-1:2018, 3.1.1]

3.16
greenhouse gas activity data
GHG activity data
activity data
quantitative measure of activity that results in a *GHG emission* (3.17) or GHG removal

[SOURCE: ISO 14064-1:2018, 3.2.1, modified — The term "activity data" has been added as a third term and the example has been deleted.]

3.17
greenhouse gas emission
GHG emission
release of a *GHG* (3.15) into the atmosphere

[SOURCE: ISO 14064-1:2018, 3.1.5]

3.18
greenhouse gas emission factor
GHG emission factor
coefficient relating *GHG activity data* (3.16) with the *GHG emission* (3.17)

[SOURCE: ISO 14064-1:2018, 3.1.7, modified — Note to entry 1 has been deleted.]

3.19
greenhouse gas inventory
GHG inventory
list of *GHG sources* (3.20) and GHG sinks, and their quantified *GHG emissions* (3.17) and GHG removals

[SOURCE: ISO 14064-1:2018, 3.2.6]

3.20
greenhouse gas source
GHG source
process (3.35) that releases a *GHG* (3.15) into the atmosphere

[SOURCE: ISO 14064-1:2018, 3.1.2]

3.21
gross calorific value
GCV
amount of heat released during the combustion of a specified amount of a fuel.

Note 1 to entry: It includes the latent heat contained in water vapour, which is released when condensing water vapour so that all water is in liquid state (often expressed in GJ per tonne of fuel).

Note 2 to entry: Compare with the IPCC 2019 guidelines, Vol. II, Section 1.4.1.2[23].

Note 3 to entry: Also referred to as "higher heat value" (HHV).

3.22
indirect greenhouse gas emission
indirect GHG emission
GHG emission (3.17) that is a consequence of an *organization's* (3.32) operations and activities, but that arises from *GHG sources* (3.20) that are not owned or controlled by the organization

Note 1 to entry: These emissions occur generally in the upstream and/or downstream chain.

[SOURCE: ISO 14064-1:2018, 3.1.11]

3.23
key performance indicator
KPI
type of measure of performance used by industry

Note 1 to entry: KPIs are commonly used by an *organization* (3.32) to evaluate its success or the success of an activity in which it is engaged.

3.24
level of assurance
degree of confidence in the *GHG* (3.15) statement

[SOURCE: ISO 14064-1:2018, 3.4.13]

3.25
loss on ignition
test consisting of strongly heating (igniting) a sample of the material at a specified temperature, allowing volatile substances to escape, until its mass ceases to change

Note 1 to entry: This test is used in inorganic analytical chemistry, particularly in the analysis of minerals.

3.26
lower heat value
LHV
absolute value of the specific heat (enthalpy) of combustion, for unit mass of the fuel burned in oxygen at constant pressure under such conditions that all the water of the reaction products remains as water vapour (at 0,1 MPa), the other products being as for the *gross calorific value* (3.21), all at the reference temperature

Note 1 to entry: Also referred to as "net calorific value" (NCV).

[SOURCE: ISO 1928:2020, 3.1.3, modified — The term "net calorific value at constant volume" has been replaced with "lower heat value" and Note 1 to entry has been added.]

3.27
mass balance
relationship between input and output quantity of a specific substance in a defined system, taking into account the formation or decomposition of that substance in the system

3.28
mixed fuel
fuel that is a mix of *biomass* (3.6) and fossil fuel

Note 1 to entry: It is fuel with a certain *biogenic carbon* (3.4) content.

3.29
monitoring
continuous or periodic assessment of *GHG emissions* (3.17), GHG removals or other GHG-related data

[SOURCE: ISO 14064-1:2018, 3.2.12]

3.30
monitoring plan
basis for the *emissions report* (3.9), which defines and describes where and how the emissions of a *facility* (3.11) are determined, taking into account the nature and functioning of the facility to which it applies

3.31
operational control
organization's (3.32) full authority to introduce and implement its operating policies at an operation

Note 1 to entry: This criterion is usually fulfilled if an organization is the operator of a *facility* (3.11), i.e. if it holds the operating licence. Under this approach, companies consolidate 100 % of the emissions of those operations over which they have operational control. As an exception, consolidation in accordance with *equity share* (3.10) is required for joint ventures where partners have joint operational control.

3.32
organization
person or group of people that has its own functions with responsibilities, authorities and relationships to achieve its objectives

Note 1 to entry: The concept of organization includes, but is not limited to, sole-trader, company, corporation, firm, enterprise, authority, partnership, association, charity or institution, or part or combination thereof, whether incorporated or not, public or private,

[SOURCE: ISO 14064-1:2018, 3.4.2]

3.33
organizational boundary
grouping of activities or *facilities* (3.11) in which an *organization* (3.32) exercises *operational control* (3.31) or *financial control* (3.12) or has an *equity share* (3.10)

[SOURCE: ISO 14064-1:2018, 3.4.7, modified — The word "control" has been added after "operational".]

3.34
plant
technical entity for the production of a specific product

Note 1 to entry: A plant consists of various tools necessary to the operation of a *process* (3.35).

3.35
process
single or multiple operations delivering a specific product or set of products

Note 1 to entry: Also referred to as "activity", but the term "activity" is more largely used in *activity data* (3.16) which are the basis of a *GHG* (3.15) estimate.

3.36
process emission
emission from industrial *processes* (3.35) including chemical and mineralogical transformations other than combustion

3.37
reporting boundary
grouping of *GHG emissions* (3.17) or GHG removals reported from within the *organizational boundary* (3.33), as well as those significant indirect emissions that are a consequence of the *organization's* (3.32) operations and activities

[SOURCE: ISO 14064-1:2018, 3.4.8]

3.38
source stream
<consumption> specific fuel type, raw material or product giving rise to emissions of relevant *GHGs* (3.15) at one or more emission sources as a result of its consumption or production

3.39
source stream
<calculation> specific fuel type, raw material or product containing carbon and included in the calculation of *GHG emissions* (3.17) using a *mass balance* (3.27) methodology

3.40
specific emission
emission expressed on a per unit output basis

EXAMPLE In kilogrammes of *carbon dioxide equivalent* (3.7) per tonne of product.

3.41
total carbon
sum of total organic carbon and *total inorganic carbon* (3.42)

3.42
total inorganic carbon
carbon that is mostly bound in the mineral matter of materials

EXAMPLE Carbonates in fuel ashes.

3.43
traditional fuel
fossil fuel including mainly coal, petroleum coke, lignite, shale, petroleum products and natural gas

3.44
uncertainty
parameter associated with the result of quantification that characterizes the dispersion of the values that could be reasonably attributed to the quantified amount

Note 1 to entry: Uncertainty information typically specifies quantitative estimates of the likely dispersion of values and a qualitative description of the likely causes of the dispersion.

[SOURCE: ISO 14064-1:2018, 3.2.13]

3.45
verification
process (3.35) for evaluating a statement of historical data and information to determine if the statement is materially correct and conforms to criteria

[SOURCE: ISO 14064-1:2018, 3.4.9]

3.46
validation
process (3.35) for evaluating the reasonableness of the assumptions, limitations and methods that support a statement about the outcome of future activities

[SOURCE: ISO 14064-1:2018, 3.4.10]

3.47
certification
issue of a statement by third party, based on a decision following a review, that fulfilment of specified requirements has been demonstrated

4 Abbreviated terms

AMS	automated measuring systems
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
GCV	gross calorific value
GHG	greenhouse gas
GWP	global warming potential
HHV	higher heat value
KPI	key performance indicator
LHV	lower heat value
m^3	normal cubic meter (at 1 013,25 hPa and 273,15 K)
NCV	net calorific value
OPG	on-site power generation
QA/QC	quality assurance and quality control

5 Principles

5.1 General

The application of principles is fundamental to ensure that GHG-related information is a true and fair account. The principles are the basis for, and will guide the application of, the requirements in this document.

Accounting and performance assessment of GHG emissions shall be based on the principles as referenced in ISO 14064-1:2018, 4.1 to 4.6 and described in 5.2 to 5.6.

5.2 Relevance

It should be ensured that the GHG inventory appropriately reflects the relevant GHG emissions of the reporting entity and serves the decision-making needs of users (both internal and external to the organization).

5.3 Completeness

The operator should account for and report on all GHG emission sources and activities within the chosen reporting boundary. To reach completeness, any gaps should be avoided, and any specific exclusion shall be disclosed and justified.

5.4 Consistency

Consistent methodologies should be used to allow for meaningful comparison of emissions over time. Any changes to the data, reporting boundary, methods or any other relevant factors in the time series should be documented transparently.

5.5 Accuracy

For high accuracy, it shall be ensured that the quantification of GHG emissions is systematically neither over nor below actual emissions, as far as can be judged, and that uncertainties are reduced as far as practicable (see also Clause 9). Sufficient accuracy should be achieved to enable users to make decisions with reasonable assurance as to the integrity of the reported information.

5.6 Transparency

All relevant issues should be addressed in a factual and coherent manner, based on a clear audit trail, to aim at transparency. Any relevant assumptions should be disclosed. Appropriate references should be made to the accounting and mass balance methodologies and data sources used.

6 Inventory boundaries

6.1 Organizational boundaries

This document may be applied based on an organization, facility or plant. The organization may comprise one or more facilities. A facility may comprise one or more plants. Facility-level and plant-level GHG emissions may be produced from one or more GHG sources.

The organization shall consolidate its facility-level GHG emissions by using one of the following approaches:

a) control: the organization accounts for all quantified GHG emissions from facilities over which it has financial or operational control; or

b) equity share: the organization accounts for its portion of GHG emissions from respective facilities.

The organization may use a different consolidation methodology where specific arrangements are defined by a GHG programme or legal contract.

When a facility is controlled by several organizations, these organizations should adopt the same consolidation methodology.

The organization shall document which consolidation method it applies.

The organization shall explain any change to the selected consolidation method.

Guidance on applying control and equity share approaches to consolidate facility-level GHG emissions to the organization level is included in ISO 14064-1.

6.2 Reporting boundaries

6.2.1 General

Reporting boundaries refer to the types of sources covered by an inventory. They may cover all the existing activities of a sector or be limited to a part of them considered as core activities. Generally, all emission sources necessary for producing the reference product should be included.

In the context of reporting boundaries, ISO 14064-1 applies. GHG emissions shall be aggregated into the following categories in accordance with ISO 14064-1:2018:

a) direct GHG emissions;

b) indirect GHG emissions from imported energy;

c) indirect GHG emissions from transportation;

d) indirect GHG emissions from products used by organization;

e) indirect GHG emissions associated with the use of products from the organization;

f) indirect GHG emissions from other sources.

NOTE In the context of reporting boundaries, this document was originally developed from the concept of scopes as defined in the revised World Resources Institute/World Business Council for Sustainable Development (WRI/WBCSD) Protocol[24].

— Direct GHG emissions (category 1) occur from sources that are owned or controlled by the organization. For example, emissions from combustion in owned or controlled boilers, furnaces, vehicles, etc. Direct CO_2 emissions from the combustion of biomass are quantified separately. Direct GHG emissions correspond to scope 1 emissions in the WRI/WBCSD Protocol[24].

— Energy indirect GHG emissions (category 2) occur from the generation of purchased electricity, heat or steam consumed in the organization's owned or controlled equipment. These emissions physically occur at the facility where electricity, heat or steam is generated. Energy indirect GHG emissions correspond to scope 2 emissions in the WRI/WBCSD Protocol[24].

— Other indirect GHG emissions (categories 3 to 6) are a consequence of the activities of the organization but occur from sources not owned or controlled by the organization. Some examples are listed in ISO 14064-1. Other indirect GHG emissions correspond to scope 3 emissions in the WRI/WBCSD Protocol[24].

Relating to this document, reporting boundaries shall cover direct GHG emissions (category 1) and indirect GHG emissions from imported energy (category 2). As far as they are needed for a fair and transparent comparison of plants/facilities, indirect GHG emissions in accordance with categories 3 to 6 shall be included for the calculation of performance indicators. The sector-specific standards give specific indications on how to set reporting boundaries.

Absolute GHG emissions (e.g. in tonnes CO_2e per year) shall be reported based on direct GHG emissions. Indirect GHG emissions from imported energy should be reported separately. Performance assessment shall be based on direct GHG emissions, indirect GHG emissions from imported energy and relevant other indirect GHG emissions as defined in the sector-specific standards.

NOTE See Annex F for "categories correspondence" between ISO 14064-1, ISO/TR 14069 and categorizations from the GHG Protocol.

6.2.2 Establishing reporting boundaries

The organization shall establish and document its reporting boundaries. The establishment of reporting boundaries includes:

— identifying GHG emissions associated with the organization's operations, facility or plant;

— categorizing GHG emissions into direct emissions (category 1), indirect emissions from imported energy (category 2) and indirect emissions in accordance with categories 3 to 6.

The sector-specific standards define which of the indirect emissions in accordance with categories 3 to 6 shall be quantified and reported. The organization shall explain any changes to its reporting boundaries.

6.2.3 Direct GHG emissions (category 1)

The organization shall quantify direct GHG emissions from facilities within its organizational boundaries.

Direct GHG emissions can arise from electricity, heat and steam generation, and from the generation of process emissions within the reporting boundary. Direct GHG emissions from electricity, heat and steam generated and exported or distributed by the organization may be reported separately, but shall not be deducted from the organization's or facility's total direct GHG emissions.

NOTE The term "exported" refers to electricity, heat or steam that is supplied by the organization to users outside the organizational boundaries.

Where the generation of electricity, heat or steam solely uses fuel inputs, GHG emissions shall be counted as direct GHG emissions of the electricity, heat or steam unit. When they solely use energy derived from on-site processes, e.g. waste heat or pressure, the direct GHG emissions shall be counted as part of direct GHG emissions of the process producing the waste heat or pressure. When they use a combination of fuel inputs and energy derived from on-site processes, the direct GHG emissions shall be pro-rated accordingly.

GHG emissions from the combustion of biomass shall be determined but reported separately from the direct GHG emissions (for more details, see Annex E). The non-biogenic fraction of GHG emissions from the alternative fuels should be determined and reported in the direct GHG emissions.

With respect to the performance assessment, the sector-specific standards provide requirements for the quantification and reporting of direct GHG emissions from the various types of electricity, steam or heat generation to ensure consistent and transparent performance comparisons. The sector-specific standards specify how to account for and assign direct GHG emissions from electricity, heat or steam which is exported or distributed.

6.2.4 Indirect GHG emissions (categories 2 to 6)

The organization shall quantify indirect GHG emissions from the generation of imported electricity, heat or steam consumed by the organization (category 2).

NOTE 1 The term "imported" refers to electricity, heat or steam that is supplied from outside the organizational boundaries.

The organization shall quantify significant indirect GHG emissions from categories 3 to 6 in accordance with the requirements of the relevant sector-specific standard.

In accordance with ISO 14064-1:2018, 5.2.3, criteria of significance to determine direct and indirect emissions within the reporting boundary are described in the sector-specific standards of the ISO 19694 series. The intended use of this document and the related sector-specific standards is to provide a basis for comparability of industrial plants and KPIs.

Total absolute emissions shall be reported as the direct GHG (category 1) emissions and energy indirect (category 2) emissions only. In respect of the performance assessment, direct GHG emissions, indirect emissions from imported energy and, where required by the sector-specific standards, other indirect GHG (categories 3 to 6) emissions shall be quantified and reported to ensure consistent and transparent comparisons.

NOTE 2 Examples of organizational activities that can result in indirect emissions of categories 3 to 6 are included in ISO 14064-1:2018, Annex B.

6.2.5 GHG from electricity use and on-site power production

Within the emissions inventory, GHG emissions from electricity imported within the reporting boundaries (externally purchased power) are counted as indirect emissions. In accordance with requirements of ISO 14064-1:2018, B.3, and the WRI/WBCSD Protocol (Chapter 4 and Appendix A)[24], emissions associated with transmission and distribution losses (T&D losses) shall not be included in this calculation.

With respect to power generation within the boundaries of the reporting entity, this document distinguishes between power generation based on separate on-site power generation (OPG) (e.g. in a power plant, separate fuels are used) and energy recovery (e.g. waste heat or pressure, no additional fuels used) including the combination of both (gross power production and net power output).

Where appropriate, the sector-specific standards offer a more detailed description about how to report emissions from power use, on-site power production both by energy recovery and separate OPG as well as from power purchase and sales. Principally a distinction should be drawn between the different power sources (purchase, production on-site) and paths of power usage: use for production processes,

consumption of power generation auxiliaries (difference between gross and net power production of the power plant) and power sold externally.

In the case of producing power in a separate power plant on-site (i.e. within the reporting boundaries), the GHG emissions are counted as direct emissions of the power unit.

In the case of power generation from energy recovery originating from the respective process (e.g. cement kiln or blast furnace), any additional fuel used for power generation is counted in this process, and consequently emissions are counted as direct GHG emissions for power generation.

In the case of exporting energy flows across the reporting boundary, the inventory should include these energy flows as well as, in the case of power, indirect emissions deriving from them.

With respect to performance assessment, the sector-specific standards explain if and how absolute or product specific values or KPIs shall recognize any benefits, e.g. from internal use or external delivery of heat or power generated on-site, in order to allow a fair and transparent comparison of plants.

7 Performance assessment (principle)

Performance assessment shall provide a consistent and transparent framework allowing comparison of operations or evaluation of progress over time. For these reasons, the performance assessment is process-based and can be independent from organizational boundaries.

The sector-specific standards describe the methodology and KPI(s) used to carry out the performance assessment. As a general principle, performance is assessed by means of KPI(s) expressed in GHG emissions per unit of reference product. Such KPI(s) may be supplemented by others in order to give a broader view on performance.

8 General requirements for identifying, calculating and reporting of GHG emissions

8.1 Identification, calculation and reporting of GHG emissions

The requirements for identifying, calculating and reporting of GHG emissions are as follows.

a) The organization shall establish a historical base year for GHG emissions and removals for comparative purposes or to meet GHG programme requirements or other intended uses of the GHG inventory.

b) Each operator shall identify and calculate GHG emissions, based on a monitoring plan and taking into account the nature and functioning of the installation to which it applies.

c) The monitoring plan shall be supplemented by written procedures, which the operator establishes, documents, implements and maintains for activities under the monitoring plan, as appropriate.

d) The operator shall prepare an emissions report for the relevant period.

e) All records needed for the purpose of this document shall be filed, kept and maintained to ensure traceability of the data and to allow verification. A documented procedure shall be established to define the controls needed for the identification, storage, protection, retrieval, retention and disposition of records. Records shall remain legible, readily identifiable and retrievable.

This basic concept is described in detail in the sector-specific parts of the ISO 19694 series.

8.2 Content of the monitoring plan

The operator shall comprise a monitoring plan, i.e. GHG determination and reporting plan based on the standard for the sector-specific type of installation.

The monitoring plan shall consist of a detailed, complete and transparent documentation of the monitoring methodology of a specific installation. It shall contain at least the elements laid down in Annex A and any other requirements laid down in the sector-specific standards.

Together with the monitoring plan, the operator shall provide the following supporting documents:

a) evidence for each source stream and emission source demonstrating conformity to the uncertainty thresholds for activity data and calculation factors, where applicable, as defined in the sector-specific standards;

b) the results of an assessment of quality and completeness of the achieved data.

9 Determination of GHG emissions: general requirements

9.1 General

GHGs can be determined by direct measurement, mass balance techniques or mixtures of the two. The choice of the appropriate methodology should be guided by the requirement to obtain accurate results with acceptable measurement uncertainties at reasonable costs.

The determination of GHGs may be achieved by direct measurement using permanently installed analysers. This method is particularly useful in those instances where mass balance techniques are inappropriate, e.g. for N_2O emissions. For sites using fuels and raw materials which display little compositional variation, a mass-balance-based approach can be the most appropriate option both in terms of cost and measurement uncertainty. More information is given in the sector-specific standards.

9.2 Mass balanced based method

The carbon mass balance is a method for determining CO_2 emissions by balancing all carbon-containing materials entering and leaving a system. The carbon mass flow of the input streams shall be compared with the carbon mass flow of the output streams. The difference of both is the carbon loss in the form of CO_2. Using mass-balance-based methodologies, emissions from source streams are determined based on input or production data obtained by means of measurement systems and additional parameters from laboratory analyses (calorific factor, carbon content, biomass content, etc.) and/or standard factors.

For the determination of GHG emissions from materials, products and fuels, in principle, the following data are needed:

— mass or volume flows (activity data);

— emission factors;

— calorific values (for fuels);

— oxidation or conversion factors.

Activity data represents information on consumption of fuel, input material or production output expressed as energy (GJ) or as mass or volume (t or m^3) in the case of fuels, and mass or volume in the case of raw materials or products (t or m^3) in a given reporting period, e.g. one year. The determination of activity data by the operator may either be based on their measurement or calculation before or behind the process, or based on a material balance of fuel or material, as shown by Formula (1):

$$M_C = M_P + (M_S - M_E) - M_O \quad (1)$$

where

M_C is material consumed during the reporting period;

M_P is material procured during the reporting period;

M_S is material stock at the beginning of the reporting period;

M_E is material stock at the end of the reporting period;

M_O is material used for other purposes (transportation or re-sold).

Emission factors are expressed as tCO_2e/GJ (combustion emissions), or tCO_2e/t or tCO_{2e}/Nm^3 (process emissions). For the use of reference emission factors, refer to Clause 12. For the conversion of carbon into the respective value for CO_2, the factor of 3,664 (tCO_2/t C) shall be used. Emission factors are usually determined by laboratory analyses.

Lower heat values of fuels are usually expressed as GJ/t or GJ/m^3. The applied calorific value shall always match the status of the fuel, especially with respect to the correct moisture content during its weighing (e.g. raw coal or dried coal). Lower heat values are usually determined by laboratory analyses.

An oxidation factor for combustion emissions or a conversion factor for process emissions shall be used to reflect the proportion of carbon, which is not oxidized or converted in the process. Oxidation factors are usually determined by laboratory analyses.

After discovering all relevant emission sources, the amounts of fuels and materials and their corresponding parameters form the basis to calculate the GHG emissions of each source stream.

The fuel emissions are calculated in accordance with Formula (2):

$$E = f_{consumed} \times H_i \times F_E \times F_O \quad (2)$$

where

E are the total annual GHG emissions of the regarding fuel in t CO_2e/year;

$f_{consumed}$ is the amount of fuel consumed in t/year;

H_i is the lower heat value (LHV) in GJ/t;

F_E is the emission factor in t CO_2e/GJ;

F_O is the oxidation factor (dimensionless); an oxidation factor of 1 means complete oxidation.

Process or material specific emissions are calculated in accordance with Formula (3):

$$E = M_{consumed} \times F_E \times F_C \quad (3)$$

where

E are the total annual GHG emissions of the regarding material in t CO_2e/year;

$M_{consumed}$ is the amount of material consumed in t/year;

F_E is the emission factor in t CO_2e/GJ;

F_C is the conversion factor (dimensionless); a conversion factor of 1 means complete conversion.

Where these general methods cannot be applied, the most appropriate method is described in the sector-specific parts of the ISO 19694 series.

As a first step, all relevant input and output fuel and material mass flows of the plant shall be identified. If not available already, for that purpose, a flow chart of the plant and/or relevant processes should be developed in accordance with the reporting boundaries. The next step is to determine the amount of these mass flows on a yearly basis. These data are usually available in an organization's data system, based on measurements and/or supplier invoices. The locations of scales, meters and other devices for the quantitative determination of each mass flow should also be included in a flow chart. A low uncertainty level should be reached in the determination of activity data (see Clause 11 for the assessment of uncertainties).

Besides the yearly amount of all relevant mass flows, additional information on several flow parameters is needed for the assessment of GHG emissions. Depending on the type of mass flow, the parameters given in Table 1 shall be determined.

Table 1 — Type of mass flow and required parameters (examples)

Type of mass flows		Required parameter	Measuring unit
GHG from combustion of fuels	Conventional fossil fuels	Lower heat value (LHV)	GJ/t
		Emission factor (EF)	t CO_2/GJ
		Oxidation factor (if relevant)	mass fraction
		Carbon content (in cases of a mass balance)	t C/t
	Alternative fossil fuels and mixed fuels	Lower heat value (LHV)	GJ/t
		Emission factor (EF)	t CO_2/GJ
		Biomass fraction	mass fraction
		Oxidation factor (if relevant)	mass fraction
		Carbon content (in cases of a mass balance)	t C/t
	Biomass fuels	Lower heat value (LHV)	GJ/t
		Emission factor (EF)	t CO_2/GJ
		Oxidation factor (if relevant)	mass fraction
		Carbon content (in cases of a mass balance)	t C/t
GHG from processes	Raw materials containing carbonates	Content of relevant carbonates (e.g. $CaCO_3$, $MgCO_3$) or CO_2 content (EF)	mass fractions or t CO_2/t
		Conversion factor	mass fraction
	Raw materials containing organic carbon	Total organic carbon content	mass fraction
	Output materials containing oxides from carbonate sources	Content of relevant oxides (e.g. CaO, MgO)	mass fraction
		Conversion factor	mass fraction
	Materials causing other GHG emissions (e.g. CH_4, N_2O)	Emission factor (EF)	t CO_2e/t
		Conversion factor	mass fraction

The parameters may be determined in different ways, including by:

a) laboratory analyses of material samples; or

b) using reference factors on a regional, national or international (IPCC[23]) level.

It is preferable to determine the fuel and material parameters by analysis if this can be done by an accredited laboratory, a laboratory belonging to the organization itself (e.g. a plant lab) or another competent laboratory.

9.3 Stack emission measurement-based method

The determination of GHG emissions by stack measurements consists of the combination of:

— volume flow measurement;

— gas concentration measurement.

Where GHGs are measured directly by permanently installed automated measuring systems (AMS) [continuous emission monitoring systems (CEMS)], those instruments shall meet the quality assurance and quality control (QA/QC) requirements of applicable standards.

NOTE 1 QA/QC requirements for AMS are specified in, for example, ISO 14385-1, ISO 14385-2 and EN 14181.

NOTE 2 They are called "automated measuring systems" in ISO 14385-1, ISO 14385-2, EN 14181, EN 15267-1, EN 15267-2, EN 15267-3 and other environmental protection monitoring standards developed under CEN/TC 264, *Air Quality*, and this terminology is used in this document. They are called "continuous emission monitoring systems" in EU Commission Regulation 601/2012[20].

Presently such monitors are commercially available for the three most important components: CO_2, CH_4 and N_2O. Each operator may choose to measure, to calculate the concentration of one or more GHGs at its own discretion, and to measure or calculate the total volumetric flow. High attention shall be paid to the consistency of the concentration and flow monitors as well as to the validation of the monitors.

Each measuring device shall be appropriately calibrated. The chosen flow monitors for measuring volume flow and gas concentration shall fulfil the requirements in ISO 16911-1 and ISO 16911-2. The performance test report shall quote the achieved uncertainties during the field test as repeatability standard deviation at lower point, zero if possible and span point. These figures shall be used for calculation of total uncertainty. The test report shall be issued by a testing laboratory meeting the requirements of ISO/IEC 17025.

NOTE 3 The performance tests of concentration and of flow monitors are specified in, for example, EN 15267-1, EN 15267-2 and EN 15267-3. For instruments tested under these standards, the performance test report and the test certificate quote the achieved uncertainties during the field test.

Regular quality assurance of the monitors shall be performed in accordance with applicable standards (e.g. EN 14181). Before installation of an instrument or combination of instruments, the expected uncertainty of the final installation shall be calculated in accordance with ISO 14956 or with a relevant regional or national standard.

The monitor used shall be tested by an independent body meeting the requirements of ISO/IEC 17025. The uncertainty is understood as the single-sided 95 % confidence interval for each individual ½-h value or h value in percentage of the measured value, including the random uncertainty contribution from the standard reference method (SRM) used for calibration.

The overall uncertainty of stack measurement of one GHG is the combined uncertainties of flow measurement and of gas concentration measurement.

10 General requirements for sampling, analyses and laboratory competency

10.1 Sampling and analyses — Reference to standards or guidelines, methods and frequencies

Where calculation factors are determined by analyses, the operator shall establish a sampling plan for each carbon-containing mass flow (source streams). This sampling plan shall give information on the methods used for the preparation, storage and transport of the samples, including information on responsibilities, locations, frequencies and quantities.

The operator shall ensure that the samples are representative for the relevant batch or delivery period and are free of bias. To this purpose, the sampling methods shall be based on applicable international,

regional or national standards. Where such standards are not available, the methods shall be based on applicable draft standards or on industry best practice, limiting sampling and measurement bias.

The sampling frequency shall be such that it limits the uncertainty to acceptable levels. Special attention shall be paid to carbon-containing mass flows with a high level of heterogeneity.

The sector-specific standards give specific instructions about the sampling of the main carbon-containing mass flows of the sectors as well as indicative sampling rates.

The procedures applied for analyses of relevant data shall be, where available, in accordance with a standardized method that limits measurement bias and has a known analysis uncertainty. International Standards shall be used if available. If International Standards are not available, applicable other (e.g. regional or national) standards shall apply. Where no applicable standards exist, procedures may be carried out where possible in accordance with suitable draft standards or industry best practice guidelines. For applicable standards and guidelines, see the WRI/WBCSD Protocol[24]. The sector-specific standards give more detailed guidance where required.

10.2 Requirements for laboratories and evidence of their technical competence

The operator shall ensure that laboratories used to carry out analyses for the determination of calculation factors meet the requirements of ISO/IEC 17025, for the relevant analytical methods.

A laboratory that does not meet the requirements of ISO/IEC 17025 may be used for the determination of calculation factors where the operator can demonstrate that access to laboratories referred to in the paragraph above is not practically feasible and where such a laboratory meets requirements equivalent to ISO/IEC 17025.

With respect to quality management, the laboratory shall meet the requirements of ISO 9001 or other certified quality management systems that cover the laboratory.

Such evidence shall cover at least the following elements:

a) management of the personnel's competence for the specific tasks assigned;

b) suitability of accommodation and environmental conditions;

c) selection of analytical methods and relevant standards;

d) where applicable, management of sampling and sample preparation, including control of sample integrity;

e) where applicable, development and validation of new analytical methods or application of methods not covered by international or national standards;

f) uncertainty estimation;

g) management of equipment, including procedures for calibration, adjustment, maintenance and repair of equipment, and record keeping thereof;

h) management and control of data, documents and software;

i) management of calibration items and reference materials;

j) quality assurance for calibration and test results, including regular participation in proficiency testing schemes, applying analytical methods to certified reference materials, or inter-comparison with an accredited laboratory;

k) management of outsourced processes;

l) management of assignments, customer complaints and ensuring timely corrective action.

11 General information for the assessment of uncertainties

ISO/IEC Guide 98-3 is primarily concerned with the expression of uncertainty in the measurement of a well-defined physical quantity (the measurand) that may be characterized by an essentially unique value. ISO/IEC Guide 98-3 provides general rules for evaluating and expressing uncertainty in measurement rather than detailed, technology-specific instructions. Furthermore, it does not discuss how the uncertainty of a particular measurement result, once evaluated, may be used for different purposes.

ISO 20988 provides comprehensive guidance and specific statistical procedures for uncertainty estimation in air quality measurement. It applies the general recommendations of ISO/IEC Guide 98-3 to boundary conditions met in air quality measurement. The boundary conditions considered include measurands varying rapidly in time, as well as the presence of bias in a series of observations obtained under conditions of intended use of methods of air quality measurement. See Annex D for example calculations of the uncertainty of stack measurements.

Where standards for measurement of specific materials, energy consumption or any other emissions include the analysis of uncertainty, such requirements shall be applied.

Explanations and exclusions applying to the above-mentioned standards and ISO/IEC Guide 98-3 are made in the sector-specific standards of the ISO 19694 series, which deal with the problems specific to particular fields of measurement or with the various uses of quantitative expressions of uncertainty.

12 Reference factors

12.1 Global warming potential (GWP) factors

The emissions of each GHG shall be calculated separately and then converted to carbon dioxide equivalents (CO_2e) on the basis of their GWP. The GWP for each GHG may be taken from the latest GWP (100 year) factors published by the IPCC[23]. A record shall be maintained of the reference factors and their source in the supporting evidence.

12.2 Process emission factors

Where required, process emission factors are provided in the sector-specific standards.

12.3 Electricity emission factors

Emissions from imported electricity consumed by the organization shall be quantified by the organization using the location-based approach by applying the emission factor that best characterizes the pertinent grid, i.e. dedicated transmission line, local, regional or national grid-average emission factor. Grid-average emission factors should be from the emissions year being reported, if available, or from the most recent year if not. Grid-average emission factors for imported consumed electricity shall be based on the average consumption mix of the grid from which electricity is consumed.

A record shall be maintained of the reference factors and their source in the supporting evidence.

12.4 Fuel emission factors

Where a facility has total absolute emissions ≥ 50,000 tonnes of CO_2e per year, the operator shall determine fuel emission factors by sampling and analysing each fuel in accordance with the relevant International Standards at a frequency defined in the sector-specific standards. Where a relevant International Standard is not available, the operator may use another applicable (e.g. regional or national) standard. The operator may use fuel factors provided by the fuel supplier as long as the fuel is sampled and analysed in accordance with the requirements of this document and the relevant sector-specific standard. If analysed data are available, they should be used.

Fuel reference factors may be used:

— where a facility has total absolute emissions < 50,000 t of CO_2e per year;

— where a facility has total absolute emissions ≥ 50,000 t of CO_2e per year but the GHG emissions from the particular fuel are ≤ 1,000 t of CO_2e per year;

— where the operator can demonstrate that it is not technically or economically feasible to sample or analyse the fuel;

— for conventional fossil fuels (e.g. heavy or light fuel oil).

Under these circumstances, the operator shall use fossil fuel reference factors from recognized national sources such as the latest National Greenhouse Gas Inventory as submitted to the United Nations Framework Convention on Climate Change (UNFCCC) by the country in which the facility is located. Where national data are not available, the operator shall use the latest emission factor published by the IPCC[23] or the WRI/WBCSD[24].

A record of the reference factors and their source shall be maintained in the supporting evidence, along with a justification of why it is not technically or economically feasible to sample and analyse a fuel, where appropriate.

Where the emission factor is in the format, e.g. kgCO_2/TJ, it shall be multiplied by the relevant calorific value factor for the fuel. The operator shall take care to use factors with the appropriate units. The operator shall ensure that an emission factor based on gross calorific value (GCV) [higher heat value (HHV)] is only used in conjunction with a GCV factor, and an emission factor based on net calorific value (NCV) [lower heat value (LHV)] is only used in conjunction with an NCV factor.

12.5 Biomass fuel emission factors

The materials listed in Annex B are considered as 100 % biomass fuels. It is the operator's responsibility to show evidence on the biomass status if necessary.

GHG emissions from biomass fuels shall be reported separately. Biomass emission factors for the determination of the memo item may be measured in accordance with 12.4 or use reference factors from recognized national sources such as the latest National Greenhouse Gas Inventory as submitted to the UNFCCC for the Member State or the WBCSD[24], or the IPCC default emission factor of 110 kg CO_2/GJ for solid biomass may be used. This value lies in the range of different values for solid biofuels, which are specified as default emission factors in IPCC 2019 (Vol. II, Section 1.4.2.1)[23].

A record shall be maintained of the reference factors and their source in the supporting evidence.

12.6 Mixed biomass containing fuel emission factors

The biomass fractions of mixed materials should be expressed as biogenic carbon related to total carbon. The biogenic fraction may be considered as 100 % biomass and shall be reported separately in accordance with Annex E.

As most mixed fuels vary significantly in their composition over time and region, the emission factors for the fossil fuel fraction of mixed biomass containing fuels shall be determined in accordance with Clause 13.

Fuel reference factors may only be used for fuels which, due to their production process and specifications, have a specific or characteristic composition (e.g. waste tyres). For these fuels, the operator shall use the relevant factors from recognized sources, such as the latest National Greenhouse Gas Inventory as submitted to the UNFCCC for the Member State, the WBCSD[24] or the latest emission factor published by the IPCC[23].

The GHG emissions from the biomass fraction of mixed biomass fuels may be reported as a memo item. The biomass emission factors shall be determined in accordance with 12.5.

A record shall be maintained of the reference factors and their source in the supporting evidence.

13 Consideration of biomass

13.1 General

Alternative fuels or process input materials often contain a fraction of or exclusively consist of biomass. That means the amount of emitted CO_2 correlates with the amount of accumulated CO_2 during the generation period before. The CO_2 emissions of those fractions shall be determined and reported separately.

When using, or switching to, biomass as a replacement for fossil energy or process feedstock, the operator should consider the following issues as a basis for decisions and GHG accounting, including reporting:

— the effect of the substitutes on the total GHG emission;

— the effect of the substitutes on the energy efficiency of the total process or process step;

— emission factors, including CO_2, N_2O and CH_4, for the biomass considered for replacement.

13.2 Additional sources of information

Assistance for the consideration, analysing and reporting of biomass sources is provided by ISO 13833, ISO 14064-1, EN 15440 and ISO 13065, as well as and other relevant regional or national standards.

Further guidance on the determination and calculation of emissions from biomass is given in the IPCC 2019 guidelines[23]. Suitable complementary regional or national standards may be used.

13.3 Biomass

Biomass comprises organic matter consisting of, or recently derived from, living organisms (especially regarded as fuel) excluding peat, xyloid lignite (fossil wood) and fossil fractions of mixed fuels and materials. It includes products, by-products and waste derived from such material.

Alternative fuels serve as a substitute for conventional fossil fuels. They include fossil fuel-based fractions, such as waste oil and plastics, and biomass fractions, such as waste wood and sewage sludge.

Anthropogenic biogenic CO_2 emissions shall be quantified and reported separately from anthropogenic emissions.

Carbon dioxide emissions from waste incineration or burning under the waste sector can derive from both fossil and biomass materials. When waste is incinerated for energy, the CO_2, CH_4 and N_2O emissions from the biogenic part of waste are treated in the same way as emissions from other combustion of biomass or biomass-based products for energy (i.e. CO_2 emissions are recorded as an information item in the energy sector).

For CO_2 from mixed fuels with biomass and fossil fractions, in cases where biofuels are combusted jointly with fossil fuels (e.g. pre-treated industrial and/or domestic wastes), a split between the fossil and non-fossil fraction of the fuel should be established and the emission factors applied to the appropriate fractions.

These requirements are in line with the IPCC 2019 guidelines[23].

13.4 Reporting of emissions from biomass sources

GHG emissions from biomass fuels or from the biomass fraction of mixed fuels are determined in accordance with 12.5 and 12.6 and are reported separately.

13.5 Analysing methods for biomass fractions

Different standardized methodologies to analyse the biomass content of solid alternative fuels are available. Particularly for the monitoring and reporting of GHG, the selective dissolution method (SDM) or the C-14 method shall be performed in accordance with the applicable standards.

NOTE For example, EN 15440 describes these methodologies (see EN 15440:2011, Annex A, for the SDM and EN 15440:2011, Annex C, for the C-14 method, as well as the corresponding standards EN 15442 and EN 15407).

For measuring biogenic CO_2 emissions from stationary sources (e.g. combustion gases from stacks), ISO 13833 may be applied. This standard is also based on the C-14 method and contains references to applicable standards in connection with measurements of stationary source emissions (e.g. ISO 16911-1, ISO 16911-2 and EN 15259).

14 Verification

For the purposes of transparency in reporting CO_2 emissions to interested parties, the inventory and any associated assertion may be verified in accordance with the requirements identified in Annex C. ISO 14064-3 also gives guidance on the verification of GHG emissions and removals.

Annex A
(normative)

Minimum content of the monitoring plan

The monitoring plan shall contain at least the following information:

a) general information:

   1) a description of the organization and activities for the scope considered;

   2) a description of the procedure for managing the assignment of responsibilities;

   3) a description of the written procedures of the data flow activities;

   4) a description of the written procedures for the control activities established;

   5) the version number and date of the monitoring plan;

b) a description of the sector-specific methodologies consisting of the following:

   1) a detailed description of the mass-balance based methodologies applied;

   2) where applicable and where the operator intends to make use of simplification for small source streams, a categorization of the source streams referring to the sector-specific standards;

   3) a description of the measurement systems used;

   4) where applicable, the default values used for calculation factors indicating the source of the factor;

   5) where applicable, a list of the analysis methods to be used;

   6) where applicable, a description of the procedure underpinning the sampling plan for the sampling of fuel and materials to be analysed;

c) a description of the measurement-based methodologies for stack emissions, where applied, including the following:

   1) any calculation formulae used for data aggregation and used to determine the emissions from each emission source as well as the method for determining whether valid hours or shorter reference periods for each parameter may be calculated, and for substitution of missing data;

   2) a list of all relevant emission points;

   3) where flue gas flow is derived by calculation, a description of the written procedure for these emission sources;

   4) a list of all relevant equipment;

   5) a description of the method, and how CO_2 arising from biomass is to be determined and subtracted from the measured CO_2 emissions.

Annex B
(informative)

List of biomass materials

Plants and parts of plants are:

— straw;

— hay and grass;

— leaves, wood, roots, stumps, bark;

— crops, e.g. maize and triticale.

The following materials are counted as biomass waste, products and residues:

— industrial waste wood (waste wood from woodworking and wood processing operations and waste wood from operations in the wood materials industry);

— used wood (used products made from wood, wood materials) and products and by-products from wood processing operations;

— wood-based waste from the pulp and paper industries, e.g. black liquor (with only biomass carbon);

— crude tall oil, tall oil and pitch oil from the production of pulp;

— lignin from the processing of plants containing lignocellulose;

— forestry residues;

— animal, fish and food meal, fat, oil and tallow;

— primary residues from the food and beverage production;

— plant oils and fats;

— manure;

— agricultural plant residues;

— sewage sludge;

— biogas produced by digestion, fermentation or gasification of biomass;

— harbour sludge and other waterbody sludges and sediments;

— landfill gas;

— charcoal;

— natural rubber or latex.

The biomass fraction of mixed materials is:

— the biomass fraction of flotsam from waterbody management;

— the biomass fraction of mixed residues from food and beverage production;

— the biomass fraction of composites containing wood;

— the biomass fraction of textile wastes;
— the biomass fraction of paper, cardboard, pasteboard;
— the biomass fraction of municipal and industrial waste;
— the biomass fraction of black liquor containing fossil carbon;
— the biomass fraction of processed municipal and industrial wastes;
— the biomass fraction of ethyl-tertiary-butyl-ether (ETBE);
— the biomass fraction of butanol;
— the biomass fraction of waste tyres resulting from natural rubber and fibres.

Fuels whose components and intermediate products have all been produced from biomass are:

— biobutanol
— bioethanol;
— biodiesel;
— biomethane;
— etherized bioethanol;
— biomethanol;
— biodimethylether;
— bio-oil (a pyrolysis oil fuel) and bio-gas;
— hydro-treated vegetable oil (HVO).

Annex C
(informative)

Requirements for the assurance of GHG data

Table C.1 — Requirements for the assurance of GHG data

Item	Requirement
Level of assurance	Assurance shall be, at least, a limited assurance done at an organization's level.
Assurer reputation	The assurer shall be a recognized, independent third-party assurance practitioner.
Scope of assured data	Assurance shall include all agreed KPIs in accordance with the relevant sector-specific standards.
Frequency of assurance	Assurance shall be carried out at least once every two years at organization level, assuring data from both years separately.
Coverage of sites	Assurers shall decide the number and location of sites to be visited in order to check the accuracy and quality from representative source data.
Sampling plan	Plants assured under other schemes [e.g. European Union Emissions Trading System (EU ETS), Clean Development Mechanism (CDM)] shall be counted as samples for GHG assurance, in order to avoid double verification.
Assurance standard	Assurance should be conducted following specifications from this document and the corresponding sector-specific parts of the ISO 19694 series, as well as from ISA E 3410, ISO 14064-3 or a similar standard.
Materiality threshold	The reported inventory total data can be accepted as valid for use if an error(s) identified in the individual inventory KPIs, in aggregate, is (are) less than or equal to ± 5 % of the inventory total declared by the reporting entity.
Assurance statement	The assurer shall provide to the organization a written assurance statement summarizing the conclusions about the GHG inventory KPIs. The statement shall include information on the basis and scope of the assurance work conducted, including explicit reference to the use of the ISO 19694 series, the number of locations visited and the corresponding percentage of GHG emissions covered by the visits.

Annex D
(informative)

Example of an uncertainty calculation for yearly output determined from stack measurements (in accordance with EN 14181)

D.1 Sources of errors

There are two sources of error when estimating the total amount of GHGs as an annual emission from each of the two parameters, i.e. volumetric flow rate and GHG-concentration.

a) The random error resulting from up to 8 760 1-h measurements. This is an error originating from influence parameters, not under control by the monitoring system, which is assumed to be Gaussian-distributed around the average reading.

b) The error from the calibration, established at the last QAL2 procedure. This is an (unknown) systematic error of each 1-h measurement originating from the fact that it is only known with a certain probability where the calibration function (calibration line) is positioned.

D.2 Calculation of annual output

D.2.1 Using directly measured values

The annual output is calculated using the use volumetric flow and GHG concentration in the operation condition. In this way, no other uncertainties are involved, as shown by Formula (D.1):

$$T_{\text{annualtotal}} = \sum_{1}^{n} T_i = \sum_{1}^{n} v_i \times c_i \tag{D.1}$$

where

T_i is the 1-h emitted mass flow;

v_i is the 1-h volumetric flow reading in the operating condition;

c_i is the 1-h GHG concentration reading in the operating condition;

n is the number of 1-h readings obtained in any single calendar year.

D.2.2 Using normalized values

If v_i or c_i or both are in the normalized condition, the uncertainty contribution from temperature, pressure, humidity and oxygen measurements shall be added.

The parameters mentioned should be used in the operation condition.

If concentration is measured in standardized or semi-standardized condition, e.g. by an extractive gas analysis method, the uncertainty contribution from measurement of temperature and pressure for calculating the concentration back to operation condition (as the volumetric flow is measured), shall be added, using the method described in D.2.3 to D.2.5.

D.2.3 Propagation of random errors

An EU guideline is available to calculate the propagation of error, see Reference [21]. When the distribution of error is assumed to be Gaussian, the total error of a product (or division) of individual factors is expressed as shown by Formula (D.2):

$$u_i = \sqrt{\sum_1^n u_i^2} \tag{D.2}$$

where

u_t is the combined relative random error of the result;

u_i is the relative random error of the i^{th} factor/divisor;

n is the number of factors/divisors in the formula.

In the case where the 1-h mass emission is calculated from the 1-h average of the volumetric flow in the operating condition and the 1-h average of the GHG concentration in the operating condition, the total relative random uncertainty of each 1-h mass emission contribution is as shown by Formula (D.3):

$$u_i = \sqrt{u_{ci}^2 + u_{vi}^2} \tag{D.3}$$

where

u_i is the relative uncertainty of the i^{th} 1-h mass emission;

u_{ci} is the relative uncertainty of the i^{th} 1-h concentration;

u_{vi} is the relative uncertainty of the i^{th} 1-h volumetric flow.

The propagation of independent relative errors of summations (of differences) follows Formula (D.4):

$$u_t = \frac{\sqrt{\sum_1^n (U_i \times X_i)^2}}{\left|\sum_1^n X_i\right|} \tag{D.4}$$

where

u_t is the relative uncertainty of the result of the summation (X_t);

U_i is the relative uncertainty for i^{th} addend, X_i;

X_i is the i^{th} addend.

Since the annual mass emission is calculated as the summation of up to 8 784 1-h GHG mass emission calculations, the total uncertainty may be calculated using Formula (D.4).

D.2.4 Calculating random uncertainty for CO_2

Since errors from pollutant monitoring in accordance with EN 14181 are assumed constant in the monitoring range and in the time span from one QAL2 to the next QAL2 procedure, the random uncertainty of the annual GHG emission may be expressed as shown by Formula (D.5):

$$u_t = \frac{\sqrt{n \times \hat{U}^2}}{n \times \hat{X}} = \frac{\hat{U}}{\sqrt{n} \times \hat{X}} = \frac{\hat{u}}{\sqrt{n}} \tag{D.5}$$

where

u_t is the total uncertainty contribution for the annual emission;

$\hat{u}$ is the average random uncertainty of the 1-h CO_2 emission in engineering units;

$\hat{u}$ is the average random relative uncertainty of the 1-h CO_2 emission;

$\hat{X}$ is the average of the 1-h CO_2 emission in engineering units;

n is the number of 1-h readings in any calendar year.

As can be seen, the more 1-h readings are aggregated in a calendar year, the less importance does the uncertainty of the 1-h readings play. If a full calendar year is aggregated, consisting of 8 760 1-h readings, the 1-h relative uncertainty shall be reduced by a factor of 93,6 to reach the uncertainty contribution from the monitoring process. If ½-h readings are used, the ½-h relative uncertainty shall be reduced by a factor of 132,4 to reach the uncertainty contribution from the monitoring process.

It can be concluded that the random error originating from the individual 1-h or ½-h reading in most cases may be neglected.

D.2.5 Total uncertainty

The error originating from systematic errors in the monitoring systems are not changed in the process of calculation an annual emission but are carried on 1:1 to the result.

The systematic error from the monitoring equipment is the uncertainty of the calibration function, i.e. the lack of knowledge about where exactly the calibration function lays (see D.1).

From the QAL2 calibration in accordance with EN 14181, the expanded uncertainty of a 95 % confidence interval for the calibration line is estimated as shown by Formula (D.6):

$$U_{95} = 1,96 \times s_r \tag{D.6}$$

where

U_{95} is the one-sided 95 % confidence interval of the calibration function;

s_r is the repeatability standard deviation obtained at the last QAL2 calibration in accordance with EN 14181:2014, Formula (11).

$$s_r = \sqrt{\frac{1}{N-1} \times \sum_{i=1}^{N} (D_i - \bar{D})^2} \tag{D.7}$$

where

N is the number of paired measurements calibration in accordance with EN 14181:2014, Formula (16);

D_i is the difference of the value measured by the SRM and the value measured by the calibrated AMS;

$\bar{D}$ is the arithmetic mean of D_i.

NOTE It is assumed that the measurements are Gaussian (normal) distributed and consequently the 95 % confidence interval is obtained by multiplying the repeatability standard deviation by a factor of 1,96.

For the total uncertainty, the uncertainty contribution of the volumetric flow and the uncertainty contribution of the GHG concentration shall be considered. The combined relative uncertainty is calculated as the independent uncertainty of a product, as shown by Formula (D.8):

$$U_{\text{total}} = \sqrt{U_{95,\text{flow}}{}^2 + U_{95,\text{conc}}{}^2} \tag{D.8}$$

where

U_{total} is the combined relative uncertainty expressed as 95 % confidence interval of the emission of one GHG from an emission source determined by AMS;

$U_{95,\text{flow}}$ are the relative expanded uncertainties of volume flow measurement;

$U_{95,\text{conc}}$ the concentration measurement.

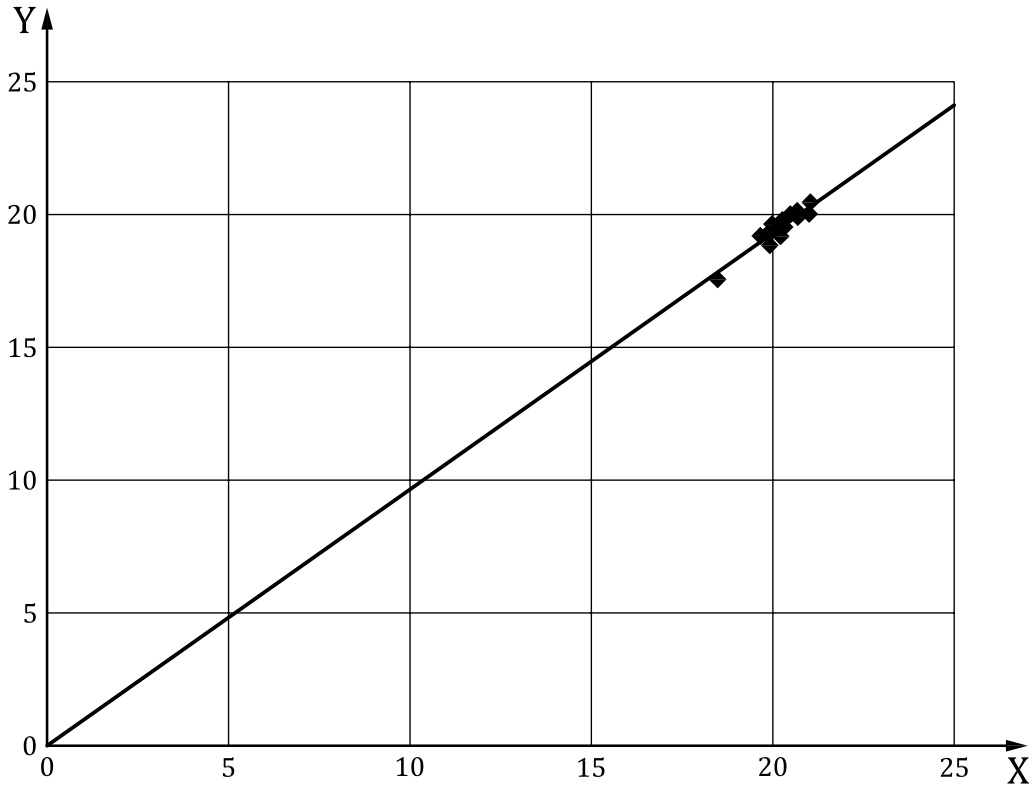
If a QAL2 procedure is performed during a calendar year, and the uncertainty is changed, the uncertainty calculation shall be performed in two steps, covering the time before and after the new QAL2 data are implemented.

If one or both of those two parameters are measured in non-standardized conditions, the uncertainty of these measurements used to standardize shall be added to Formula (D.8).

If a method to measure the fossil share of the total CO_2-emissions is implemented, the uncertainty of that method shall be added to Formula (D.8).

D.2.6 Examples

Figure D.1 illustrates an example of a flow calibration.



Key

X AMS (m/s)

Y SRM (m/s)

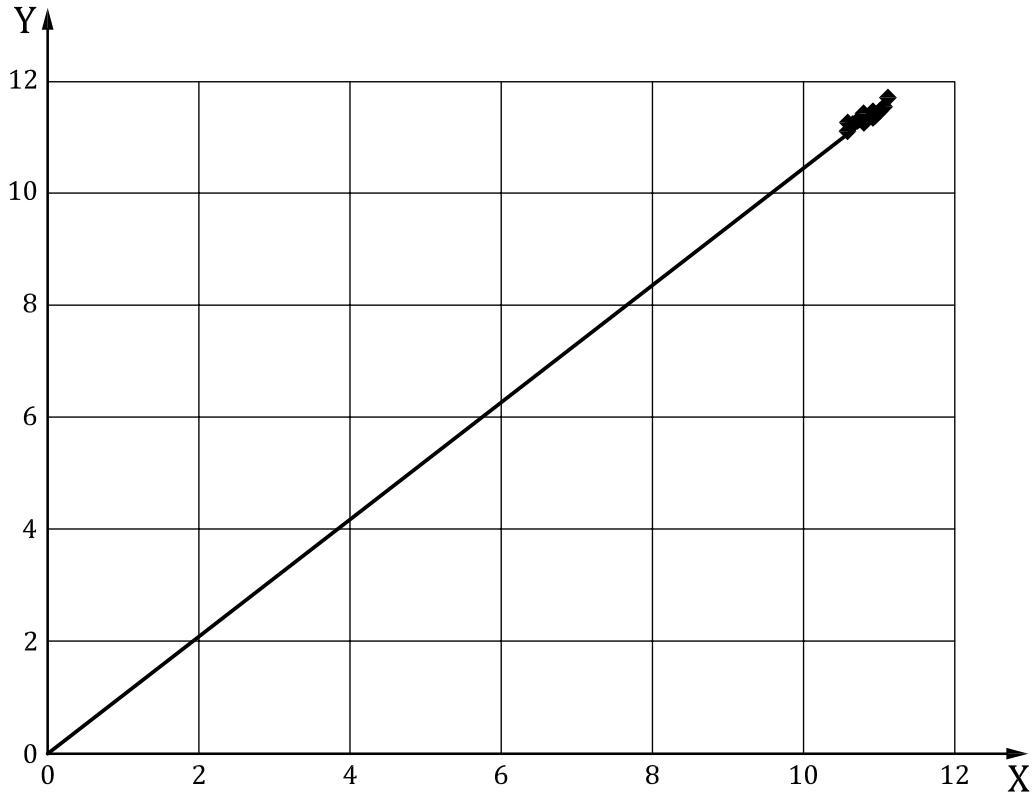
s_r = 0,171 m/s

Average flow = 19,55 m/s

This gives $U_{95,flow}$ = 0,335 m/s or 1,714 % of average as 95 % confidence interval.

Figure D.1 — Example of a flow calibration

Figure D.2 illustrates an example of a CO_2 calibration.



Key

X AMS (volume fraction in %)

Y SRM (volume fraction in %)

s_r = 0,044 3 vol % CO_2

Average CO_2 = 11,32 %

This gives $U_{95,conc}$ = 0,086 8 vol % CO_2 or 0,767 % of average

Figure D.2 — Example of a CO_2 calibration

The total uncertainty as 95 % confidence interval is in accordance with Formula (D.8):

$$U_{\text{total year}} = \sqrt{1{,}714^2 + 0{,}767^2} = 1{,}878$$

Annex E
(normative)

Treatment of biogenic GHG emissions and CO_2 removals

This annex provides requirements and guidance for the treatment of biogenic GHG emissions and CO_2 removals.

Anthropogenic biogenic GHG emissions and removals are a result of human activity. Anthropogenic biogenic GHG emissions (e.g. CO_2, CH_4 and N_2O) can result from biomass combustion as well as from other processes (e.g. aerobic and anaerobic decomposition of biomass and soil organic matter).

Anthropogenic biogenic CO_2 emissions and removals shall be quantified and reported separately from anthropogenic emissions. Anthropogenic biogenic emissions and removals of other GHGs (e.g. CH_4 and N_2O) shall be quantified and reported as anthropogenic.

Accounting for biomass emissions for KPIs is specified by the sector-specific standards in the ISO 19694 series.

Annex F
(informative)

Categories correspondence

Table F.1 — Categories correspondence

New categorizations from ISO 14064-1:2018	New categorizations from ISO/TR 14069:—[a]		Categorizations from ISO/TR 14069:2013	Categorizations from GHG Protocol	References of the corresponding clause from the revised ISO/TR 14069:—[a]
1	1.1	Direct emissions from stationary combustion	1	Scope 1 (direct)	5.2.2.2 a) and 6.5.1.1
	1.2	Direct emissions from mobile combustion	2		5.2.2.2 b) and 6.5.1.2
	1.3	Direct process emissions and removals from industrial processes	3		5.2.2.2 c) and 6.5.1.3
	1.4	Direct fugitive emissions from the release of GHG in anthropogenic systems	4		5.2.2.2 d) and 6.5.1.4
	1.5	Direct emissions and removals from land use, land use change and forestry (LULUCF)	5	Optional information	5.2.2.2.e) and 6.5.1.5
2	2.1	Indirect emissions from imported electricity	6	Scope 2 (indirect) – generation of consumed energy	5.2.3.2 a) and 6.5.2.1
	2.2	Indirect emissions from imported energy other than electricity	7		5.2.3.2 b)
3	3.1	Indirect emissions from upstream transport and distribution for goods	12	Scope 3, Category 4: Upstream transportation and distribution	5.2.3.3 a) and 6.5.3.1 Tables 8 to 12 (examples)
	3.2	Indirect emissions from downstream transport and distribution for goods	17	Scope 3 Category 9: Downstream transportation and distribution	5.2.3.3 b) and 6.5.3.2
	3.3	Indirect emissions from employee commuting	22	Scope 3, Category 7: Employee Commuting	5.2.3.3 c) and 6.5.3.3
	3.4	Indirect emissions from client and visitor transport	16	Not applicable	5.2.3.3 d) and 6.5.3.4 Tables 13 to 15 (examples)
	3.5	Indirect emissions from business travel	13	Scope 3, Category 6: Business travel	5.2.3.3.e) and 6.5.3.5
4	4.1	Indirect emissions from purchased goods	8 and 9	Scope 3, Category 1: Purchased goods and services and Scope 3, Category 3: Fuel- and energy-related activities	5.2.3.4 a) and 6.5.4.1
	4.2	Indirect emissions from capital goods	10	Scope 3, Category 2: Capital goods	5.2.3.4 b) and 6.5.4.2 Tables 16 and 17 (examples)

[a] Under preparation. Stage at the time of publication: ISO/TR CD 14069:2020.

Table F.1 *(continued)*

New categorizations from ISO 14064-1:2018	New categorizations from ISO/TR 14069:—[a]		Categorizations from ISO/TR 14069:2013	Categorizations from GHG Protocol	References of the corresponding clause from the revised ISO/TR 14069:—[a]
	4.3	Indirect emissions from the disposal of solid and liquid wastes	11	Scope 3, Category 5: Waste generated in operations	5.2.3.4 c) and 6.5.4.3 Tables 18 to 20 (data disaggregation and examples)
	4.4	Indirect emissions from the use of assets	14	Scope 3, Category 8: Upstream leased assets	5.2.3.4 d) and 6.5.4.4
	4.5	Indirect emissions from the use of other services	9	Scope 3, Category 1: Purchased goods and services	5.2.3.4.e) and 6.5.4.5
5	5.1	Indirect emissions or removals from the use stage of the product	18	Scope 3, Category 10: Processing of sold products and Scope 3, Category 11: Use of sold products	5.2.3.5 a) and 6.5.5.1
	5.2	Indirect emissions from downstream leased assets	21	Scope 3, Category 13: Downstream leased assets	5.2.3.5 b) and 6.5.5.2
	5.3	Indirect emissions from end of life stage of the product	19	Scope 3, Category 12: End-of-life treatment of sold products	5.2.3.5 c) and 6.5.5.3
	5.4	Indirect emissions from investments	15	Scope 3, Category 15: Investments	5.2.3.5 d) and 6.5.5.4
6	6	Indirect GHG emissions from other sources	23	Not applicable	5.2.3.6 and 6.5.6
	Comment:		NOTE Former category 20 has been removed because franchisees' emissions should be considered within the operational boundaries of the organization (see 5.1.2.1). The GHG Protocol includes the emissions from the operation of franchises in Scope 3, Category 14: Franchises.		

[a] Under preparation. Stage at the time of publication: ISO/TR CD 14069:2020.

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