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Sustainability criteria for bioenergy

Critères de durabilité pour la bioénergie

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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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Foreword

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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 on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is Project Committee ISO/PC 248, *Sustainability criteria for bioenergy*.

Introduction

The production and use of bioenergy have potential roles in mitigating climate change, promoting energy security and fostering sustainable development. This International Standard is designed to provide a consistent basis on which the sustainability of bioenergy can be assessed within a defined context and for a specified purpose. This International Standard provides principles, criteria and indicators. The principles reflect aspirational goals while the criteria and indicators address sustainability aspects and the information that is to be provided. However, the indicators in this International Standard might not comprehensively capture all sustainability aspects for all bioenergy processes.

Virtually every country in the world uses some form of bioenergy. Various types of biomass are used for the production of bioenergy through many types and sizes of economic operations. The characteristics of bioenergy production therefore are heterogeneous and depend on several factors, such as geography, climate, level of development, institutions and technologies.

The purpose of this International Standard is to provide a framework for considering environmental, social and economic aspects that can be used to facilitate the evaluation and comparability of bioenergy production and products, supply chains and applications. As part of the development of this International Standard, other relevant sustainability initiatives and International Standards were considered.

This International Standard aims to facilitate the sustainable production, use and trade of bioenergy and will enable users to identify areas for continual improvement in the sustainability of bioenergy. It can be used in several ways. It can facilitate business-to-business communications by providing a standard framework that allows businesses to "speak the same language" when describing aspects of sustainability. Purchasers can use this International Standard to compare sustainability information from suppliers to help identify bioenergy processes and products that meet their requirements. Other standards, certification initiatives and government agencies can use this International Standard as a reference for how to provide information regarding sustainability.

This International Standard does not provide threshold values. Threshold values can be defined by economic operators in the supply chain and/or other organizations (e.g. government). Sustainability information provided through the use of this International Standard can then be compared with defined threshold values.

In International Standards, the following verbal forms are used:

— "shall" indicates a requirement;

— "should" indicates a recommendation;

— "may" indicates a permission;

— "can" indicates a possibility or a capability.

Further details can be found in the ISO/IEC Directives, Part 2.

Sustainability criteria for bioenergy

1 Scope

This International Standard specifies principles, criteria and indicators for the bioenergy supply chain to facilitate assessment of environmental, social and economic aspects of sustainability.

This International Standard is applicable to the whole supply chain, parts of a supply chain or a single process in the supply chain. This International Standard applies to all forms of bioenergy, irrespective of raw material, geographical location, technology or end use.

This International Standard does not establish thresholds or limits and does not describe specific bioenergy processes and production methods. Compliance with this International Standard does not determine the sustainability of processes or products.

This International Standard is intended to facilitate comparability of various bioenergy processes or products. It can also be used to facilitate comparability of bioenergy and other energy options.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/TS 14067:2013, *Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification and communication*

3 Terms and definitions

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

3.1
allocation
partitioning the input or output flows of a *process* (3.36) or a *product system* (3.38) between the product system under study and one or more other product systems

[SOURCE: ISO 14040:2006, 3.17]

3.2
biodiversity
biological diversity
variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic *ecosystems* (3.14) and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems

[SOURCE: United Nations Convention on Biological Diversity[27]]

3.3
bioenergy
energy derived from *biomass* (3.4)

Note 1 to entry: Biomass can be processed into solid, liquid or gaseous fuels or stored energy in biomass can be directly converted into other forms of energy (e.g. heat, light).

3.4
biomass
raw material (3.40) of biological origin excluding material embedded in geological formations or transformed to fossilized material

[SOURCE: ISO 13833:2013, 3.2, modified — The word "raw" has been added, because "*raw material* (3.40)" is also defined in this International Standard, and "fossil" has been changed to "fossilized material".]

3.5
book and claim
chain-of-custody (3.7) system where, from the production of *raw material* (3.40) to the final *product* (3.37) for consumption, the information on *sustainability* (3.48) is decoupled from the physical product

Note 1 to entry: The system allows for the product itself and attributes of sustainability to be traded separately.

3.6
carbon dioxide equivalent
CO_2 equivalent
CO_2e
unit for comparing the radiative forcing of a *greenhouse gas* (3.21) to that of carbon dioxide

Note 1 to entry: Mass of a greenhouse gas is converted into CO_2 equivalents using global warming potentials.

[SOURCE: ISO/TS 14067:2013, 3.1.3.2, modified — Original Note 2 to entry has been omitted.]

3.7
chain-of-custody
chain of responsibility for or control of materials as they move through each step of the *process* (3.36) or *product system* (3.38) under assessment

3.8
child labour
work that deprives children of their childhood, their potential and their dignity, and that is harmful to their physical and mental development

Note 1 to entry: This is a frequently used definition according to the International Labour Organization (ILO).

[SOURCE: International Labour Organization, "What is child labour"[22], modified]

3.9
competent national authority
applicable national regulatory body or authority designated or otherwise recognized as such by the national regulatory body for any purpose in connection with the requirements, recommendations and *principles* (3.34), *criteria* (3.11) and *indicators* (3.27) in this International Standard

[SOURCE: ISO 16883:2007, 3.1, modified — The word "national" has been added to term, "any" has been changed to "applicable", "by the national regulatory body" has been added and "regulations specified" has been changed to "requirements, recommendations and principles, criteria and indicators".]

3.10
co-product
any of two or more *products* (3.37) coming from the same *unit process* (3.51) or *product system* (3.38)

[SOURCE: ISO 14040:2006, 3.10]

3.11
criterion
requirement that describes what is to be assessed

Note 1 to entry: A criterion adds meaning and operability to a *principle* (3.34) without itself being a direct measure of performance.

Note 2 to entry: A criterion is characterized by a set of related *indicators* (3.27).

3.12
direct effects
measurable environmental, social and economic effects under the direct control of the *economic operator* (3.13) and caused by the *process* (3.36) being analysed

Note 1 to entry: Activities under direct control are defined as activities conducted by or subcontracted by the economic operator.

Note 2 to entry: Subcontracted activities are activities undertaken by a subcontractor, being an *organization* (3.33) that undertakes aspects of the processing, handling, storage, transport or distribution of the *products* (3,37), *co-products* (3.10) or *waste* (3.52) on behalf of the *economic operator* (3.13), on a contractual basis, either paid or non-paid.

Note 3 to entry: Direct effects within the scope of this International Standard are considered under the *criteria* (3.11) and *indicators* (3.27) in Clause 5.

Note 4 to entry: *Processes* (3.36) inside the defined *system boundaries* (3.50) are included based on International Standards (e.g. ISO 14040 and 14044) even if they are outside the direct control of the economic operator.

Note 5 to entry: Other potential effects may be added to the consideration when an international consensus standard is established for the effect.

3.13
economic operator
individual or *organization* (3.33) that has ownership or control of one or more *processes* (3.36) of the bioenergy supply chain

3.14
ecosystem
system of complex interactions between communities of plants, animals, microorganisms and their *environment* (3.16), which functions as a unit

3.15
ecosystem services
benefits people obtain from *ecosystems* (3.14) including provisioning, regulating, supporting, and cultural services

[SOURCE: Millennium Ecosystem Assessment: Ecosystems and Human Well-being Synthesis[26]]

3.16
environment
surroundings in which an *organization* (3.33) operates, including air, water, land, natural resources, flora, fauna, humans and their interrelations

[SOURCE: ISO 14001:2015, 3.2.1, modified — Original Notes 1 and 2 to entry have been omitted.]

3.17
food security
physical and economic access, at all times, to sufficient, safe and nutritious food to meet dietary needs and food preferences for an active and healthy life

[SOURCE: Food and Agriculture Organization of the United Nations (FAO)[18]]

3.18
forced or compulsory labour
work or service which is exacted from any person under the menace of any penalty and for which the said person has not offered himself voluntarily

[SOURCE: International Labour Organization (ILO): Forced Labour Convention (No. 29)[21]]

3.19
forest
land spanning more than 0,5 ha with trees higher than 5 m and a canopy cover of more than 10 percent or trees able to reach these thresholds *in situ*, not including land that is predominantly under agricultural or urban land use

Note 1 to entry: According to FAO, stands in agricultural production systems, such as agroforestry systems when crops are grown under tree cover, fruit tree plantations and oil palm plantations, are excluded. FAO provides additional explanation about what a forest includes (see Reference [19]).

[SOURCE: FAO Forestry Paper 163[19], modified — Additional explanation about what a forest includes has been omitted and Note 1 to entry has been added.]

3.20
global warming potential
GWP
characterization factor describing the radiative forcing *impact* (3.26) of one mass-based unit of a given *greenhouse gas* (3.21) relative to that of carbon dioxide over a given period of time

Note 1 to entry: "Characterization factor" is defined in ISO 14040:2006, 3.37.

[SOURCE: ISO/TS 14067:2013, 3.1.3.4, modified — Original Note 1 to entry has been omitted, because this is addressed in Note 1 to definition of "greenhouse gas".]

3.21
greenhouse gas
GHG
natural or anthropogenic gaseous constituent of the atmosphere 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: A list of greenhouse gases with their recognized *global warming potentials* (3.20) is provided in ISO/TS 14067:2013, Annex A.

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

[SOURCE: ISO/TS 14067:2013, 3.1.3.1, modified — The qualifier "both natural and anthropogenic" has been changed to "natural or anthropogenic" and moved to beginning of definition.]

3.22
greenhouse gas emission
GHG emission
release of a *greenhouse gas* (3.21) to the atmosphere

[SOURCE: ISO/TS 14067:2013, 3.1.3.5, modified — The verb "released" has become the subject of the definition as "release", replacing "mass", and the original source reference has been omitted.]

3.23
greenhouse gas removal
GHG removal
removal of a *greenhouse gas* (3.21) from the atmosphere

[SOURCE: ISO/TS 14067:2013, 3.1.3.6, modified — The verb "removed" has become the subject of the definition as "removal", replacing "mass", and the original source reference has been omitted.]

3.24
hazardous work
work which by its nature or the circumstances in which it is carried out is likely to harm the health, safety or morals of persons

Note 1 to entry: This definition refers specifically to hazardous work by persons as defined in Table G.1.

3.25
human rights
rights inherent to all human beings, whatever their nationality, place of residence, sex, national or ethnic origin, colour, religion, language or any other status

Note 1 to entry: Universal human rights are often expressed and guaranteed by law in the form of treaties, customary international law, general principles and other sources of international law. International human rights law lays down obligations of governments to act in certain ways or to refrain from certain acts in order to promote and protect human rights and fundamental freedoms of individuals or groups.

[SOURCE: United Nations Office of the High Commissioner for Human Rights[29], modified]

3.26
impact
change, adverse or beneficial, caused by the *process* (3.36) being assessed

[SOURCE: ISO 15392:2008, 3.13, modified — The words "any" and "that may be" have been omitted and "caused by the process being assessed" has been added.]

3.27
indicator
quantitative, qualitative or binary variable that can be measured or described, in response to a defined *criterion* (3.11)

3.28
land use change
change in the use or management of land by humans, which can lead to a change in land cover

Note 1 to entry: A *rotation period* (3.43) in a management cycle does not constitute land use change.

[SOURCE: IPCC Fourth Assessment Report[24], modified]

3.29
land use rights
form of land tenure, whether formal or informal, including customary rights or traditions

Note 1 to entry: There is great variability in land use rights in different parts of the world as they relate to systems of ownership and property rights.

3.30
life cycle
consecutive and interlinked stages of a *product system* (3.38), from *raw material* (3.40) acquisition or generation from natural resources to final disposal

[SOURCE: ISO 14040:2006, 3.1]

3.31
light work
work that is not likely to be harmful to a person's health or development and does not interfere with a child's attendance at school or participation in vocational orientation or training programmes or a person's capacity to benefit from the instruction received

Note 1 to entry: This definition refers specifically to light work by persons as defined in Table G.1.

3.32
mass balance
chain-of-custody (3.7) system where, from the production of a *raw material* (3.40) to the final *product* (3.37) for consumption, the information on *sustainability* (3.48) can be traced to a specific production quantity

Note 1 to entry: The system allows for mixing of products with differing information on sustainability or with no information on sustainability.

3.33
organization
company, corporation, firm, enterprise, cooperative, authority or institution, or part or combination thereof, whether incorporated or not, public or private, that has its own functions and administration

Note 1 to entry: For organizations with more than one operating unit, a single operating unit may be defined as an organization.

[SOURCE: ISO 14064-1:2006, 2.22, modified — The word "cooperative" has been added to the definition and Note 1 to entry has been added.]

3.34
principle
aspirational goal that governs decisions or behaviour

3.35
procedure
specified way to carry out an activity or a *process* (3.36)

Note 1 to entry: Procedures can be documented or not.

Note 2 to entry: When a procedure is documented, the term "written procedure" or "documented procedure" is frequently used. The document that contains a procedure can be called a "procedure document".

[SOURCE: ISO 9000:2015, 3.4.5, modified — Note 2 to entry has been added.]

3.36
process
set of interrelated or interacting activities which transforms inputs into outputs

Note 1 to entry: Inputs to a process are generally outputs of other processes.

Note 2 to entry: Processes in an *organization* (3.33) are generally planned and carried out under controlled conditions to add value.

[SOURCE: ISO 9000:2015, 3.4.1, modified — The words "that use inputs to deliver an intended result" have been changed to "which transforms inputs into outputs" and Notes to entry have been modified.]

3.37
product
goods or service

[SOURCE: ISO 14040:2006, 3.9, modified — The word "any" has been omitted from the definition and the original Notes to entry have been omitted.]

3.38
product system
collection of *unit processes* (3.51) with elementary and product flows, performing one or more defined functions, and which models the *life cycle* (3.30) of a *product* (3.37)

[SOURCE: ISO 14040:2006, 3.28]

3.39
protected area
clearly defined geographical space, recognized, dedicated and managed, through legal means, to achieve the long-term conservation of nature with associated *ecosystem services* (3.15) and cultural values

[SOURCE: International Union for Conservation of Nature (IUCN)[25], modified]

3.40
raw material
feedstock
primary or secondary material that is used to produce a *product* (3.37)

Note 1 to entry: Secondary material includes recycled, reused or recovered material.

Note 2 to entry: Raw material/feedstock also includes agricultural, forest and processing residues.

[SOURCE: ISO 14040:2006, 3.15, modified — Feedstock has been added as a second term, the words "reused or recovered" have been added to Note 1 to entry, and Note 2 to entry has been added.]

3.41
regular work
work with the condition that the health, safety and morals of the persons concerned are fully protected and that the persons have received adequate specific instruction or training in the relevant branch of activity

Note 1 to entry: This definition refers specifically to regular work by persons as defined in Table G.1.

3.42
riparian zone
area bordering on streams, lakes and wetlands that links water to land

[SOURCE: Government of British Columbia, Ministry for Environment[20], modified]

3.43
rotation period
amount of time required to complete a full management cycle associated with the growth and harvesting of *raw material(s)* (3.40) to be used in the *process* (3.36) being analysed

Note 1 to entry: In forestry, the rotation period is the time required to establish and grow the forest to merchantable size including fallow periods.

Note 2 to entry: In agriculture, the rotation period can vary between a single, annual crop rotation and more complex rotations involving several annual and perennial crops and/or fallow periods.

3.44
segregation
chain-of-custody (3.7) system where, from the production of a *raw material* (3.40) to the final *product* (3.37) for consumption, the information on *sustainability* (3.48) remains traceable to the physical product

Note 1 to entry: The system does not permit mixing other products with differing information on sustainability or with no information on sustainability with the segregated product.

3.45
social security
access to health care and income security, particularly in cases of old age, unemployment, sickness, invalidity, work injury, maternity or loss of a main income earner

Note 1 to entry: Social security can vary from one country to another.

[SOURCE: International Labour Organization, "Social protection"[23], modified].

3.46
stakeholder
individual, group or *organization* (3.33) that can affect or be directly affected by the *process* (3.36) under assessment within the *supply chain* (3.47)

Note 1 to entry: Stakeholders may include regulatory bodies, customers, neighbours, local communities, employees, suppliers, etc.

[SOURCE: ISO 13824:2009, 3.20, modified — Wording aligned to the context of this International Standard instead of general principles on risk assessment of systems involving structures, and Note 1 to entry has been added.]

3.47
supply chain
linked set of resources and *processes* (3.36) that begins with the sourcing of *raw material* (3.40) (including *biomass* (3.4) production where applicable) and extends through transport and storage of *products* (3.37) to the end user

Note 1 to entry: The supply chain may include raw material producers, vendors, manufacturing facilities, logistics providers, internal distribution centres, distributors, wholesalers and other entities that lead to the end user.

[SOURCE: ISO 28000:2007, 3.9, modified — The words "including biomass production where applicable", "and including" and "raw material producers" have been added; "the delivery" has been changed to "transport and storage", and "or services" and "across the modes of transport" have been omitted.]

3.48
sustainability
goal of sustainable development which encompasses environmental, social and economic aspects, in which the needs of the present are met without compromising the ability of future generations to meet their needs

Note 1 to entry: Environmental, social and economic aspects interact and are interdependent. They are referred to as the three pillars of sustainability.

Note 2 to entry: Sustainability is a comparative concept, not a state or absolute value.

3.49
sustainability aspect
element of activities or *products* (3.37) of an *economic operator* (3.13) that can have environmental, social and economic *impacts* (3.26)

3.50
system boundary
set of criteria specifying which *unit processes* (3.51) are part of a *product system* (3.38)

[SOURCE: ISO 14040:2006, 3.32, modified — Original Note to entry has been omitted.]

3.51
unit process
smallest element considered in the life cycle inventory analysis for which input and output data are quantified

[SOURCE: ISO 14040:2006, 3.34]

3.52
waste
substances or objects which the holder intends or is required to dispose of

[SOURCE: ISO 14040:2006, 3.35, modified — Original Note to entry has been omitted.]

3.53
water-scarce country
country where annual water supplies drop below 1 000 m^3 per person

[SOURCE: United Nations Department of Economic and Social Affairs, Freshwater availability in the world, on a country basis, in 2007]

4 General requirements and recommendations

4.1 General

Clause 4 contains overarching elements that are applicable to the indicators in this International Standard. This clause includes requirements that need to be fulfilled when providing information in accordance with Clause 5 and recommendations as well as guidance to help the user to better understand this International Standard.

The effort expended to respond to the indicators in Clause 5 should not impose undue administrative or economic burden for the economic operator. This International Standard therefore offers flexibility, allowing the economic operator to deal with the sustainability aspects that are relevant and significant to the operator's activities (see 4.5) and to use aggregated data and information (see 4.9).

4.2 Purpose and context

The purpose of conducting the assessment using this International Standard shall be clearly documented. The context shall also be documented including geographic areas, level of aggregation and affected stakeholders. The purpose and context are necessary to determine the scope of assessment (see 4.3) relevance and significance (see 4.5) and methods for data representation (see 4.9).

4.3 Scope of assessment

The scope of assessment describing the bioenergy process(es) and products, resources and business units to be included, shall be documented. Processes under direct control include activities conducted by or subcontracted by the economic operator (see 3.12). Any exclusion of a process or part of a process under the direct control of the economic operator (e.g. raw material selection, processing or waste disposal) shall be documented and justified.

The economic operator should consider the ability to facilitate comparability (see 4.11).

4.4 Stakeholder involvement

Stakeholders can have concerns related to the economic operator's activities.

Where required in this International Standard, the economic operator shall document how stakeholders were engaged.

NOTE "Engaged" means both that stakeholders were informed and provided opportunity to comment and that the economic operator provided a documented response to legitimate grievance presented by stakeholders.

The economic operator:

— shall identify stakeholders that are relevant to achieving the outcomes of this International Standard;

— should identify relevant concerns (e.g. requirements) of these stakeholders;

— should identify which of these concerns will be dealt with by legal requirements.

4.5 Relevance and significance

The economic operator shall provide the information required by every indicator of this International Standard for all relevant and significant sustainability aspects within the scope of the assessment. The economic operator may exclude aspects that it documents and justifies as not being relevant or significant.

A sustainability aspect is relevant if it is part of or affected by the process within the scope of the assessment and has a clear relationship to the purpose and context (see 4.2).

Significance may be determined by a risk assessment or other procedures (e.g. buyer requirements, regulatory requirements, concern of stakeholders, scale of operation).

Figure 1 provides a decision tree on how to categorize relevance and significance for each aspect.

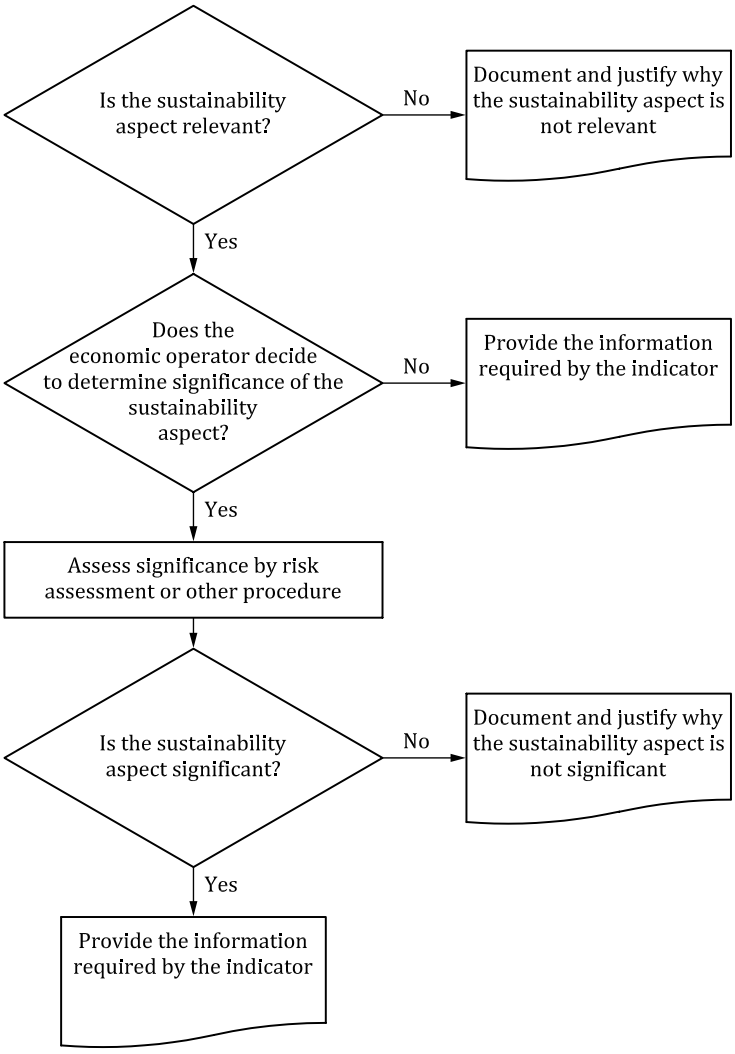


Figure 1 — Decision tree for categorizing relevance and significance for each indicator

4.6 Recording of legal requirements

The economic operator shall identify legal requirements related to the relevant sustainability aspects described in Clause 5, and shall document how these are addressed within the responses to the indicators of this International Standard. An economic operator may also document instances where laws applicable to the economic operator establish different requirements compared to the sustainability aspects of this International Standard.

4.7 Time periods

The assessment of sustainability aspects shall cover the relevant time period in the life cycle. Sustainability aspects can have different time periods. The time period selected for each sustainability aspect shall be documented and justified.

In case of production of primary raw materials, the crop rotation period could vary from a few months in paddy crops to more than 100 years in long-rotation forestry, for example. Time periods for handling of secondary raw materials can vary greatly depending on time needed for transport, storage and processing/refinement.

The choice of time periods for which data are collected shall consider the potential intra- and inter-annual variations and, if relevant, use values representing the trend over the selected periods.

The time period for which data and information are collected shall be documented and justified.

4.8 Science-based approach

When making assumptions or selecting data or methodologies to be used in reporting under this International Standard, preference shall be given to scientific approaches or traditional practices based on natural, social or economic sciences.

Science is the pursuit of knowledge and understanding of the natural and social world following a systematic methodology based on evidence. Scientific methodology typically involves the following:

— objective observation: measurement and data (possibly although not necessarily using mathematics as a tool);

— evidence;

— experiment, models and/or observation as benchmarks for testing hypotheses;

— induction: reasoning to establish general rules or conclusions drawn from facts or examples;

— repetition;

— critical analysis; and

— verification and testing: critical exposure to scrutiny, peer review and assessment.

4.9 Data and information

The data, information sources and assumptions used shall be documented and justified. The economic operator shall provide information on direct effects of its process(es).

NOTE Providing information does not imply that the economic operator is required to publicly provide its proprietary information, being information that is not public knowledge (such as certain financial data, test results or trade secrets) and that is viewed as the property of the holder. The recipient of proprietary data, such as a contractor in the procurement process, is generally duty bound to refrain from making unauthorized use of the information.

Primary data should be collected for all individual processes under the direct control of the economic operator and shall be representative of the processes for which they are collected. Primary data should be used for all significant sustainability aspects and can be collected from a specific site, or can be averaged across all sites that contain the processes within the scope of the assessment. Primary data can be measured or modelled.

Secondary data should only be used for inputs where the collection of primary data is not possible or practicable, or for minor processes. Secondary data may include literature data, calculated data, estimates or other representative data. Use of secondary data shall be documented and justified with references.

Data may be aggregated. The level of aggregation shall be consistent with and appropriate to the purpose. The aggregation of the data shall be consistent with the scope of the assessment, scale of operation, requirement or level of concern of stakeholders, and shall be representative of the operations being assessed.

The economic operator may prepare a report summarizing the results of the assessment along with a description of any bioenergy processes that were included in the assessment. Annex A provides a format that can be used to summarize information.

Information may be shared and aggregated between or across stages of supply chains.

When there is agreement to share information, it shall be done in a way that allows the information to be combined within one supply chain or aggregated across supply chains.

No statements or communications about the sustainability of bioenergy processes or products shall be made based solely on the use of this International Standard.

4.10 Traceability

Traceability relates to the origin of raw materials and parts, the processing history and the distribution and location of the product after delivery. If the economic operator decides to or is required to inform about traceability, the economic operator shall at least disclose the following information:

a) part(s) of the supply chain applying this International Standard;

b) whether or not a chain-of-custody system is adopted; and

c) chain-of-custody system(s) adopted.

NOTE Not all economic operators will be able to inform about traceability, and when such condition occurs aggregated data can be used.

Three common chain-of-custody systems are:

— segregation (see 3.44);

— mass balance (see 3.32); and

— book and claim (see 3.5).

Chain-of-custody systems may be used singly or in combination.

4.11 Comparability

The use of this International Standard for comparison of indicators between various energy options (both bioenergy and non-bioenergy) is optional. Some principles, criteria and indicators in this International Standard may not be applicable to all other energy options. Further, other energy options may have additional principles, criteria and indicators that are not included in this International Standard.

If energy options are compared, all indicators in this International Standard should be considered. Each indicator relevant to an energy option compared should be assessed using a consistent approach, consistent system boundaries, and relevant data. Comparing the GHG emissions of the bioenergy option to another energy option shall be in accordance with 6.9.

The complete results should be transparently presented in any comparison. Any divergences in indicators considered or divergences in methods to measure the indicators should be identified and reported. Additionally, sustainability information tables (see Annex A) can be used to present the results.

The sustainability of compared energy options cannot be determined based solely on the use of this International Standard. No statements or communications about the sustainability of an energy option should be made based on the use of this International Standard.

4.12 Direct and indirect effects

In developing this International Standard, issues concerning direct and indirect effects were carefully considered. The aim of this International Standard is to provide clear guidance to produce consistent and replicable results. The term "indirect effects" can be understood in different ways due to various opinions and definitions. This International Standard considers the measurable environmental, social and economic effects that are under the direct control of the economic operator and caused by the process being assessed. For the purpose of this International Standard, these are defined as "direct effects". Other effects that do not meet these requirements are not included in this International Standard.

4.13 Ecosystem services

A concept that was examined during the development of this International Standard was the importance of functional ecosystems and the services that they provide to the production of bioenergy.

Ecosystems contribute to the well-being of society by providing services such as food, water, fuel, flood control, soil, pollinators, natural fibres, recreation and the absorption of pollution and waste. As ecosystems are degraded or destroyed, they lose the ability to provide these services. Several of the criteria in this International Standard relate to the functions of healthy ecosystems that provide natural goods and services that contribute to human well-being.

5 Principles, criteria and indicators

5.1 General

The economic operator shall document the purpose, context and scope of the assessment (see 4.2 and 4.3).

The economic operator shall address all criteria by responding to all indicators regarding activities under its direct control in accordance with 4.5.

5.2 Environmental principles, criteria and indicators

5.2.1 GHG

Principle: Reduce anthropogenic GHG emissions.

5.2.1.1 Lifecycle GHG emissions and GHG removals

Criterion: The economic operator provides information regarding life cycle GHG emissions and GHG removals.

5.2.1.1.1 Indicator: Provide, in accordance with Clause 6:

a) Sufficient data to allow the calculation of GHG emissions and GHG removals of a life cycle stage; or

b) Partial carbon footprint of the bioenergy product calculated as the sum of GHG emissions and removals of one or more processes expressed in gCO_2 equivalents per delivered unit; or

c) Life cycle carbon footprint calculated as the sum of GHG emissions and GHG removals expressed in gCO_2 equivalents per MJ energy delivered and functional unit.

5.2.1.1.2 Indicator: When a comparison is done, the life cycle GHG emissions and GHG removals of the energy that the bioenergy replaces expressed in gCO2 equivalents per functional unit shall be calculated and documented in accordance with Clause 6.

5.2.2 Water

Principle: Conserve and protect water resources.

5.2.2.1 Water quantity and quality

Criterion: The economic operator provides information on how water quantity and quality resulting from water withdrawals and releases are addressed.

NOTE For examples of responses to the indicators below, see Annex B.

5.2.2.1.1 Indicator: Describe procedures applied to identify potential impacts on water quantity including consideration of water depletion and other key chemical, physical and/or biological parameters. Describe procedures applied to identify potential impacts on water quality, including consideration of eutrophication and oxygen depletion and other key chemical, physical and/or biological parameters. The impacts to water quantity and quality shall be addressed with respect to water sources and receiving bodies.

5.2.2.1.2 Indicator: List the impacts from water withdrawals on water sources identified by applying the procedures under 5.2.2.1.1.

5.2.2.1.3 Indicator: List the impacts from water releases on the receiving body as identified by applying the procedures under 5.2.2.1.1.

5.2.2.1.4 Indicator: Describe measures taken to address the impacts identified in 5.2.2.1.2 and 5.2.2.1.3.

5.2.2.1.5 Indicator: Report the absolute or net value of key parameters or metrics used to measure the effect of addressing the impacts identified in 5.2.2.1.2 and 5.2.2.1.3.

5.2.3 Soil

Principle: Protect soil quality and productivity.

5.2.3.1 Soil quality and productivity

Criterion: The economic operator provides information on how soil quality and productivity are addressed.

NOTE For examples on responses to the indicators below, see Annex C.

5.2.3.1.1 Indicator: Describe procedures applied to identify potential impacts on soil quality and productivity, including consideration of organic carbon, nutrients, water holding capacity, and other key chemical, physical and/or biological parameters, as well as salinization.

5.2.3.1.2 Indicator: List impacts on soil quality and productivity that were identified by applying the procedures under 5.2.3.1.1.

5.2.3.1.3 Indicator: Describe measures taken to address soil quality (chemical, physical and biological) and productivity impacts as identified in 5.2.3.1.2.

5.2.3.1.4 Indicator: Describe procedures applied to identify the potential drivers of soil erosion including potential erosion resulting from rainfall, runoff and/or wind.

5.2.3.1.5 Indicator: List drivers of soil erosion as identified in 5.2.3.1.4 and describe measures taken to address them.

5.2.3.1.6 Indicator: Report the values and trends of key chemical, physical and biological parameters or metrics used to measure the effect of addressing the impacts identified in indicator 5.2.3.1.2 and the drivers identified in indicator 5.2.3.1.5.

5.2.4 Air

Principle: Promote good air quality.

5.2.4.1 Air quality

Criterion: The economic operator provides information on how air emissions are addressed.

NOTE 1 For examples of responses to the indicators below, see Annex D.

NOTE 2 Air emissions can include air pollutants, odour and noise.

5.2.4.1.1 Indicator: Describe procedures applied to identify potential air emission sources and contaminants having impacts including consideration of sulfur oxides (SO_x), nitrogen oxides (NO_x), particulate matter (PM), volatile organic compounds (VOC), carbon monoxide (CO), ammonia (NH_3) and heavy metals.

5.2.4.1.2 Indicator: List potential air emission sources, emission rates and impacts that were identified by applying the procedures under 5.2.4.1.1.

5.2.4.1.3 Indicator: Describe the measures taken to address identified air emissions and impacts listed under 5.2.4.1.2.

5.2.4.1.4 Indicator: Report the value and trends of key parameters or metrics used to measure the effect of addressing the impacts identified in indicator 5.2.4.1.2.

5.2.5 Biodiversity

Principle: Promote positive and reduce negative impacts on biodiversity.

5.2.5.1 Biodiversity within the area of operation

Criterion: The economic operator provides information on how biodiversity values are addressed within the area of operation for the process being assessed and the environment directly influenced by the economic operator.

NOTE For examples of responses to the indicators below, see Annex E.

5.2.5.1.1 Indicator: Describe procedures applied to identify potential impacts on biodiversity, including ecosystems, habitats and identified rare, threatened and vulnerable species of local, regional or global importance, including information about restrictions on the activities due to biodiversity protection purposes.

5.2.5.1.2 Indicator: List the potential impacts on biodiversity that were identified by applying the procedures under 5.2.5.1.1.

5.2.5.1.3 Indicator: Describe measures taken to address biodiversity impacts identified in 5.2.5.1.2, including those measures addressing biodiversity protection restrictions.

5.2.5.1.4 Indicator: Report the value of key parameters or metrics used to measure the effect of addressing the impacts identified in indicator 5.2.5.1.2.

5.2.5.2 Biodiversity-protected areas

Criterion: The economic operator provides information on how biomass removal is addressed from areas designated as biodiversity-protected areas under applicable national laws and regulations within International Union for Conservation of Nature (IUCN) categories I – III.

NOTE For examples of responses to the indicators below, see Annex E.

5.2.5.2.1 Indicator: Provide a map of the location of the designated biodiversity-protected area where biomass removal is allowed, showing the location and area of the designated protected area (ha) (including contiguous and non-contiguous parts of the designated protected area).

5.2.5.2.2 Indicator: Provide a map showing:

a) the location of the designated biodiversity-protected area where biomass removal is allowed; and

b) the area where the economic operator removes biomass.

5.2.5.2.3 Indicator: Describe how biomass removed by the economic operator impacts (adversely or beneficially) the biodiversity goals prescribed by management authorities for the protected area and directly influenced environment.

NOTE "Management authority" is the designated legal authority or institution responsible for the management and regulation of the protected area.

5.2.5.2.4 Indicator: Document permits obtained from the management authorities for operations in the protected areas.

5.2.6 Energy efficiency

Principle: Promote efficient use of energy resources.

5.2.6.1 Energy resources

Criterion: The economic operator provides information on how energy use and efficiency are addressed.

5.2.6.1.1 Indicator: Provide, in accordance with Clause 6:

a) sufficient data to allow calculation of units of energy required to operate and maintain the process per units of bioenergy delivered by the process of a life cycle stage; or

b) units of energy required to operate and maintain the process(es) per units of bioenergy delivered for one or more process(es) (analogous to partial carbon footprint); or

c) units of energy required to operate and maintain the process per units of bioenergy delivered across the life cycle, expressed in MJ energy input per MJ energy delivered, and MJ energy input per functional unit,.

The methodology and assumptions used to calculate the energy balance shall be transparently presented, with the presentation detailing the sources of the energy used (e.g. fossil or renewable) as well as the method used to characterize and summarize them.

5.2.6.1.2 Indicator: Describe measures taken to address energy efficiency in the processes considered in indicator 5.2.6.1.1.

5.2.7 Waste

Principle: Promote responsible management of waste.

5.2.7.1 Waste management

Criterion: The economic operator provides information on how wastes are addressed.

NOTE For examples of responses to the indicators below, see Annex F.

5.2.7.1.1 Indicator: Describe procedures applied to identify potential impacts of generated wastes on human health and the environment.

5.2.7.1.2 Indicator: List potential impacts of wastes generated that were identified by applying the procedures under 5.2.7.1.1.

5.2.7.1.3 Indicator: Describe the measures taken to address potential impacts identified in 5.2.7.1.2, including handling, separation, storing, reusing, recycling, recovering and disposal.

5.2.7.1.4 Indicator: Report the value of key parameters or metrics used to quantify the effect of measures taken to address the impacts identified in 5.2.7.1.2.

5.2.7.1.5 Indicator: List the wastes that are the subject of measures described under 5.2.7.1.3 and report the annual quantities of the listed wastes generated in units of mass or volume per unit of production.

NOTE The "unit of production" can be the functional unit in accordance with Clause 6, or a different measure of production described by the economic operator as more directly related to the waste.

5.2.7.1.6 Indicator: Report separately for each waste identified in 5.2.7.1.5 the percentage that is reused, recycled, recovered or disposed.

5.3 Social principles, criteria and indicators

5.3.1 Human rights

Principle: Respect human rights.

5.3.1.1 Universal Declaration of Human Rights

Criterion: The economic operator provides information on how the Universal Declaration of Human Rights is addressed.

5.3.1.1.1 Indicator: The economic operator's senior management has approved, then both internally and externally communicated to personnel, business partners and other relevant parties, human rights expectations of those directly linked to its operations, products or services.

5.3.1.1.2 Indicator: The economic operator has reflected the stated human rights expectations as approved and communicated under 5.3.1.1.1 in operational requirements or practices throughout its organization.

5.3.2 Labour rights

Principle: Respect labour rights.

5.3.2.1 Forced or compulsory labour

Criterion: The economic operator provides information on how forced or compulsory labour is addressed.

5.3.2.1.1 Indicator: Describe policies, procedures and practices addressing forced or compulsory labour.

5.3.2.1.2 Indicator: Percentage of employees who have the ability to terminate their own employment without intended hindrance by the employer.

5.3.2.1.3 Indicator: Percentage of employees who do not receive the overtime compensation that they have earned and are entitled to receive.

5.3.2.2 Child labour

Criterion: The economic operator provides information on how child labour is addressed.

Children are considered to be persons younger than the legal working age of a child as defined by the applicable law in the country. If no applicable law exists, use the age referenced in Annex G.

This criterion is not relevant to child labour on family business (or where it is permissible under applicable laws) and then only when work does not interfere with the child's schooling and does not put his or her health at risk.

5.3.2.2.1 Indicator: Describe policies, procedures and practices addressing child labour.

5.3.2.2.2 Indicator: Number of workers defined as children in accordance with applicable law or Annex G.

5.3.2.2.3 Indicator: Number of children (as defined in 5.3.2.2.2) that perform regular work.

5.3.2.2.4 Indicator: Number of children (as defined in 5.3.2.2.2) that perform light work.

5.3.2.3 Collective bargaining rights

Criterion: The economic operator provides information on how collective bargaining rights are addressed.

5.3.2.3.1 Indicator: Describe how legally granted collective bargaining rights are addressed, including non-interference with such rights.

5.3.2.4 Working conditions

Criterion: The economic operator provides information on how working conditions including social security and workplace health and safety are addressed.

5.3.2.4.1 Indicator: Number and percentage of employees covered by a legally enforceable contract or equivalent document covering their wages and working conditions.

5.3.2.4.2 Indicator: Describe policies, procedures and practices regarding how employees are trained for the assigned work.

5.3.2.4.3 Indicator: Describe health, safety and hygiene policies, procedures and practices.

5.3.2.4.4 Indicator: Describe policies, procedures and practices related to discrimination.

Discrimination involves any distinction, exclusion or preference that has the effect of nullifying equality of treatment or opportunity, where that consideration is based on prejudice rather than a legitimate ground. Illegitimate grounds for discrimination include but are not limited to: race, colour, gender, age, language, property, nationality or national origin, religion, ethnic or social origin, caste, economic grounds, disability, pregnancy, belonging to an indigenous people, trade union affiliation, political affiliation or political or other opinion.

Emerging prohibited grounds also include marital or family status, personal relationships and health status such as HIV/AIDS status.

NOTE The above explanation is from ISO 26000.

5.3.2.4.5 Indicator: Percentage of employees who have been trained as described in each of 5.3.2.4.3 and 5.3.2.4.4.

5.3.3 Land use rights and land use change

Principle: Respect land use rights.

5.3.3.1 Land use rights and land use change

Criterion: The economic operator provides information on how land use rights are addressed.

5.3.3.1.1 Indicator: Where traditional land use rights are applicable, is there documented evidence of a process for consulting and gaining free, prior and informed consent for the right to use the land, and documented evidence of the outcomes?

5.3.3.1.2 Indicator: Where the competent national authority has determined that there are direct effects on local food security from land use change resulting from the process being assessed, is there evidence of free, prior and informed consent from local stakeholders?

5.3.3.1.3 Indicator: Where local stakeholder consent has been sought under 5.3.3.1.2, describe the area considered to be local and the process to determine that area.

5.3.4 Water use rights

Principle: Respect water use rights.

5.3.4.1 Water availability in water-scarce countries

Criterion: The economic operator in water-scarce countries provides information on how water availability for human consumption and food production are addressed.

5.3.4.1.1 Indicator: Describe procedures applied to identify potential impacts on water availability within the affected local community, including the impacts on water quantity and quality for human consumption and food production.

5.3.4.1.2 Indicator: Describe the process to determine the affected local community.

5.3.4.1.3 Indicator: List the potential impacts that were identified by applying the procedures under 5.3.4.1.1.

5.3.4.1.4 Indicator: Describe process for consulting and gaining free, prior and informed consent from local stakeholders on water availability.

5.3.4.1.5 Indicator: Describe measures taken, including policies, procedures and practices, to address the potential impacts listed under 5.3.4.1.3.

5.4 Economic principle, criteria and indicators

5.4.1 Economic sustainability

Principle: Produce and trade bioenergy in an economically and financially viable way.

5.4.1.1 Fair business practices

Criterion: The economic operator provides information on fraudulent, deceptive or dishonest commercial business and consumer practices.

5.4.1.1.1 Indicator: Does the economic operator have procedures to identify potential issues regarding fraudulent, deceptive or dishonest commercial business and consumer practices?

5.4.1.1.2 Indicator: Can the economic operator describe the measures taken to address identified issues regarding fraudulent, deceptive or dishonest commercial business and consumer practices identified by applying the procedures under 5.4.1.1.1?

5.4.1.1.3 Indicator: Can the economic operator describe key parameters, assessments or metrics used to characterize the effect of measures taken under 5.4.1.1.2?

5.4.1.2 Financial risk management

Criterion: The economic operator provides information on financial risk management.

5.4.1.2.1 Indicator: Does the economic operator have procedures to identify potential financial risks?

5.4.1.2.2 Indicator: Can the economic operator describe the measures taken to address financial risks that were identified by applying the procedures under 5.4.1.2.1?

5.4.1.2.3 Indicator: Can the economic operator describe key parameters, assessments or metrics used to characterize the effect of measures taken under 5.4.1.2.2?

6 Greenhouse gas methodologies, assessments and comparisons

6.1 General

This clause establishes the requirements for quantifying GHG emissions to address the GHG principle (see 5.2.1). GHG quantification and reporting shall be undertaken in accordance with ISO/TS 14067 as supplemented by Clause 6. ISO/TS 14067 specifies principles, requirements and guidelines for the quantification and communication of the carbon footprint of a product (CFP), based on International Standards on life cycle assessment (ISO 14040 and ISO 14044) and on environmental labels and declarations (ISO 14020, ISO 14024 and ISO 14025). It includes requirements on data and data quality.

A CFP study assesses the GHG emissions and GHG removals in the life cycle of a product.

ISO/TS 14067 also provides the requirements and guidelines for the quantification of a partial carbon footprint of a product (partial CFP). A partial CFP is the sum of GHG emissions and GHG removals of one or more selected processes of a product system.

This International Standard does not contain requirements or guidelines for communications or labelling of the carbon footprint of a product or process. These components of ISO/TS 14067 may be used but are not required for the GHG assessment for this International Standard.

If there is a difference between ISO/TS 14067 and Clause 6 of this International Standard, Clause 6 has precedence. This clause provides requirements and guidance to supplement ISO/TS 14067 regarding issues specific to this International Standard.

If there is a carbon footprint or a partial carbon footprint calculated according to ISO/TS 14067, and its calculations also follow the additional requirements in this International Standard, that carbon footprint is acceptable as the GHG calculation. A GHG inventory quantified under ISO 14064-1 that complies with ISO/TS 14067 and this International Standard, can be used to calculate a partial carbon footprint.

Annex H provides examples of energy pathways and the life cycle stages to be considered when quantifying GHG emissions.

6.2 Special considerations for time periods for GHG assessments

6.2.1 General

Time period is an important issue in GHG assessments, as GHG emissions are subject to variation over the management cycle of the system. The assessment of GHG emissions and GHG removals should cover the relevant period in the life cycle of the product.

Examples of issues related to time period for GHG assessment:

— For systems converting biomass or biogas to electricity and/or heat, the GHG assessment should include start-up, maintenance and temporary process shutdown.

— For perennial crops the time period for assessment of GHG emissions and GHG removals including carbon stock change should consider at least one entire rotation period.

— The rotation period for perennial crops and forest can range from a few years to more than 100 years. Therefore, it can be necessary to extrapolate GHG emissions and GHG removals if data are not available for the full rotation period. It is essential to document and justify the procedures used to estimate the GHG emissions and GHG removals.

— For annual crops the time period for assessment of the GHG emissions and GHG removals including carbon stock change should be based on the relevant farming cycles including crop rotations.

— For dedicated biomass growth systems, soil carbon content with different biomass types and biomass types before and after land use changes are important to time-period-related GHG calculations.

The choice of time period for data collection should consider intra- and inter-annual variability and when possible use values representing the trend over the selected period.

The time period selected to represent the rotation period shall be documented and justified.

6.2.2 Reference system

If the process being assessed changes carbon stock in biomass or soil or non-CO_2 GHG emissions, the GHG emissions and GHG removals shall be calculated as the difference between the bioenergy case and the reference system (as defined below).

The system boundary for the bioenergy case and reference system shall be equivalent.

The reference system may be defined as:

a) “business-as-usual”: continuation of current practice based on historic data, which should cover a time period that is similar in extent and conditions to the time period to be assessed; or

b) projected future: incorporating additional data and variables such as anticipated changes in intensity of production, population, economic activities, technology or other relevant variables.

The reference system selected shall be documented and justified. Documentation shall describe verifiable sources for input data and assumptions, discuss uncertainty of variables and assumptions and present a sensitivity analysis. Documentation shall disclose the timeframe or applied reference years.

NOTE The selection of a reference system relies on understanding of past trends and natural variability in the systems, as well as projections of the future with and without the bioenergy system. Projections are subject to uncertainty.

6.3 Assigning GHG emissions or GHG removals from carbon stock change in biomass and soil to the bioenergy product

When the process under assessment causes changes in carbon stocks compared to the reference land use, the GHG emissions and GHG removals associated with these changes shall be documented and assigned to the bioenergy product.

The net changes shall be assigned to the bioenergy products across the selected time period.

The time period selected for analysis shall be documented and justified as described in 4.7 and at a minimum shall include at least one full rotation period for processes that involve growing crops or trees.

The appropriate time period may also be determined by the lifetime of the project or bioenergy plant, or program under which the bioenergy product is used.

NOTE 1 "Changes in carbon stocks" refers to changes in soil carbon and changes in above- and below-ground biomass over time, such as those associated with changes in land cover or land management in the bioenergy case compared to a reference system.

NOTE 2 If detection of soil carbon change involves direct field measurement, results depend on variables including the location of sampling sites, the number of replicate soil samples, the timing of sampling, the depth of the soil profile and the sampling techniques. The principles and rules for designing soil sampling strategies and techniques are provided in ISO 10381.

6.4 Other climate-forcing agents

This International Standard focuses on selected GHGs for which the Intergovernmental Panel on Climate Change (IPCC) provides global warming potentials used to quantify emissions in carbon dioxide equivalents. Other agents, including albedo, aerosols, latent heat and non-gaseous emissions (black carbon) are known to have potentially substantial effects on radiative forcing. These effects should be included in the life cycle analysis and integrated with the GHG analysis once internationally recognized methods are developed.

6.5 Functional and delivered units

Functional units are used as reference units to quantify the performance of a product system. A system can have a number of possible functions; functional unit(s) selection depends on the goal and scope of the GHG assessment.

Examples of functional units:

— 1 km driven by a standard passenger car according to a standardized driving cycle;

— 1 MJ of useful heat delivered by a cook stove using standardized setting, e.g. for heating 1 litre of water;

— 1 kWh of electricity provided by a power plant to the grid;

— 1 000 lumens of light emitted by an illumination device.

NOTE For further explanation of functional units, see ISO/TS 14067:2013, 6.3.3.

The delivered unit (also known as declared unit) is used instead of a functional unit when the assessment does not cover a full life cycle.

Examples of delivered units are:

— volume of bioethanol;

— mass of pellets.

GHG emissions should also be reported on the basis of 1 MJ of energy delivered.

6.6 Treatment of co-products in a GHG quantification

6.6.1 General

This International Standard is devoted to bioenergy and thus the feedstock is key for the quantification of GHG. Some bioenergy products are co-products of a multi-output process.

6.6.2 Procedures for treatment of co-products

6.6.2.1 General

Where multiple products are produced from a life cycle stage, all products should be considered in assigning GHG emissions and GHG removals.

The choice of procedures for considering co-products shall be compatible with the goal and scope definition of the GHG assessment. The selected procedures shall be documented and justified.

Procedures to consider co-products are described in 6.6.2.2 to 6.6.2.4.

A sensitivity analysis should be conducted to illustrate the consequences of using alternative procedures.

6.6.2.2 System expansion

System expansion involves expanding the product system under study to consider the fate of the co-product, that is, the product system which is displaced by the co-product. Selection of the displaced product requires identification of the marginal supply of a functionally- equivalent product. The displaced product is the marginally-supplied functionally-equivalent product. The procedure for system expansion and the selection of displaced product shall be documented and justified, with consideration of market factors that influence displacement by the co-product (see H.2 for further discussion).

6.6.2.3 Process subdivision

Process subdivision is a procedure for dividing the unit process into two or more sub-processes and collecting the input and output data related to these sub-processes. This can be applicable if the co-products can be assigned to individual sub-processes.

6.6.2.4 Allocation

Allocation is a procedure for partitioning the inputs and outputs of a life cycle stage and other relevant upstream stages among the stages' co-products or functions in a way that reflects the underlying specific parameters, such as physical relationships (e.g. mass, energy content, volume, stoichiometry) or economic value.

The sum of the allocated inputs and outputs of a life cycle stage shall be equal to the inputs and outputs of that stage before allocation.

NOTE This text is adapted from ISO 14044 and ISO/TS 14067.

6.7 Treatment of waste

If waste is used as a feedstock, the GHGs associated with its handling and processing shall be included, and any exclusion of up-stream emissions shall be documented and justified.

If a waste is used as a feedstock for bioenergy production, the alternative fate of that material shall be described (e.g. landfill, waste incineration, or decomposition on a field). If the alternative fate is included in the analysis it shall be included in the system boundaries of the reference system. The change in GHG emissions and change in carbon stock (e.g. in landfill) associated with the diversion of waste for use as bioenergy feedstock should be included in the calculation. If the inclusion of the avoided GHG emission results in a negative value, the final result for the calculation in 5.2.1.1.1 bullet c) should be assumed to be zero.

This procedure constitutes system expansion.

The treatment of waste in the GHG analysis shall be documented and justified.

6.8 System boundaries

The system boundaries shall be treated according to the guidance in ISO/TS 14067 and shall be equivalent for compared bioenergy and reference systems.

6.9 Process for comparison to determine GHG reduction

If a comparison is done, the bioenergy process shall be compared to a reference system based on the same delivered or functional units and methods in accordance with Clause 6.

Valid comparisons require the use of consistent methodologies, data and system boundaries. For any comparison the same lifecycle stages shall be included.

Annex A
(informative)

Example format for summarizing information

Table A.1 is an example of a format that can be used to summarize.

Table A.1 — Example of summary report

Purpose and context for the assessment	
Scope of the assessment (including description of bioenergy processes under assessment)	
Time period for which data and information have been collected	
Information on indicators (see Table A.2)	

Table A.2 can be used to summarize information on the indicators. With respect to the examples in the column "Reference/source of information/ justification", the economic operator would maintain the documentation types and examples listed, but would not be required to publicly provide this information.

Table A.2 — Example of sustainability information summary

Indicator	Result	Reference/source of information/ justification
Environmental indicators		
GHG		
5.2.1.1.1 Provide, in accordance with Clause 6: a) Sufficient data to allow the calculation of GHG emissions and GHG removals of a life cycle stage; or b) Partial carbon footprint of the bioenergy product calculated as the sum of GHG emissions and removals of one or more processes expressed in gCO_2 equivalents per delivered unit; or c) Life cycle carbon footprint calculated as the sum of GHG emissions and GHG removals expressed in gCO_2 equivalents per MJ energy delivered and functional unit.	**Quantitative**, expressed in gCO_2e per delivered unit if b) or expressed in gCO_2e per energy delivered and functional unit if c) a) data set b) set of values – see ISO/TS 14067 c) set of values – see ISO/TS 14067	Documented calculation according to Clause 6 Description of default values, emission factor used and their source + GHG guidelines used
5.2.1.1.2 When a comparison is done, the life cycle GHG emissions and GHG removals of the energy that the bioenergy replaces expressed in gCO_2 equivalents per functional unit shall be calculated and documented in accordance with Clause 6.	**Quantitative**, expressed in gCO_2e per functional unit	Documented calculation according to Clause 6 / ISO/TS 14067 Description of default values, emission factor used and their source + GHG guidelines used
Water		
For all indicators related to Water (5.2.2.1), see examples in Annex B.		
Soil		
For all indicators related to Soil (5.2.3.1), see examples in Annex C.		
Air		
For all indicators related to Air (5.2.4.1), see examples in Annex D.		
Biodiversity		
For all indicators related to Biodiversity (5.2.5.1 and 5.2.5.2), see examples in Annex E.		

Table A.2 *(continued)*

Indicator	Result	Reference/source of information/ justification
Energy efficiency		
5.2.6.1.1 Provide, in accordance with Clause 6: a) sufficient data to allow calculation of units of energy required to operate and maintain the process per units of bioenergy delivered by the process of a life cycle stage; or b) units of energy required to operate and maintain the process(es) per units of bioenergy delivered for one or more process(es) (analogous to partial carbon footprint); or c) units of energy required to operate and maintain the process per units of bioenergy delivered across the life cycle expressed in MJ energy input per MJ energy delivered and MJ energy input per functional unit.	**Quantitative**, expressed in MJ energy input per MJ energy delivered (or its inverse) if c) a) data set, e.g. the pressing process uses 10 kWh of electricity to produce 1 GJ of soybean oil from soybeans. Furthermore 100 MJ of heating oil are burned to produce 1 GJ of soybean oil from soy beans. One litre of soybean oil is produced by pressing 2 kg of soybeans. b) set of values – see ISO 14040 c) set of values – see ISO 14040	Documented calculation according to Clause 6 / ISO/TS 14067 Description of characterization values, default values and background data used Data set documenting fuel inputs and energy product outputs per Life cycle stage Set of subsequent life cycle stages Full life cycle until the gate of the EO facilities.
5.2.6.1.2 Describe measures taken to address energy efficiency in the processes considered in indicator 5.2.6.1.1.	**Qualitative** Reporting on measures provided by the EO	Documentation of measures taken Energy management plan Changes in energy efficiency
Waste		
For all indicators related to Waste (5.2.7.1), see examples in Annex F.		
Social indicators		
Human rights		
5.3.1.1.1 The economic operator's senior management has approved, then both internally and externally communicated to personnel, business partners and other relevant parties, human rights expectations of those directly linked to its operations, products or services.	**Qualitative** "The last social responsibility reporting has been published in 2011 and is available for download on the internet page." "The policies of the company on human rights are available at ....."	Social responsibility reporting / external verification according to ISO 26000 or other International Standard Records of external communications Records of internal communications Records of internal education for personnel Manual of company polices for employees
5.3.1.1.2 The economic operator has reflected the stated human rights expectations as approved and communicated under 5.3.1.1.1 in operational requirements or practices throughout its organization.	**Qualitative** Implemented SOP (standard operating procedures) includes human rights procedures	Social responsibility reporting / external verification according to ISO 26000 or other International Standard Records of internal communications Records of internal education for personnel Reference to SOP (standard operating procedures) handbook, company policy document Records of internal policy documentation Company CSR report Employee organizations' reports
Labour rights		

Table A.2 *(continued)*

Indicator	Result	Reference/source of information/ justification
5.3.2.1.1 Describe policies, procedures and practices addressing forced or compulsory labour.	**Qualitative** Description of policies, procedures and practices and reference to documentation	Social responsibility reporting / external verification according to ISO 26000 or other International Standard Records of internal communications Records of internal education for personnel Reference to SOP (standard operations procedures) handbook, company policy document Records of internal policy documentation Company CSR report Employee organizations' reports Contracts compared to number of workers employed Employment policies for subcontracted employees Standard contract for employees
5.3.2.1.2 Percentage of employees who have the ability to terminate their own employment without intended hindrance by the employer.	**Quantitative** Number	Employment records Records in EO legal department
5.3.2.1.3 Percentage of employees who do not receive the overtime compensation that they have earned and are entitled to receive.	**Quantitative** Number	Employment records Copies of working contracts Records of working hours
5.3.2.2.1 Describe policies, procedures and practices addressing child labour.	**Qualitative** (See Annex G for detailed description) Description of policies, procedures and practices and reference to documentation	Reference to SOP (standard operations procedures) handbook, company policy document
5.3.2.2.2 Number of workers defined as children in accordance with applicable law or Annex G.	**Quantitative** (See Annex G for detailed description) Number	Employment records Copies of working contracts Reference to applicable law
5.3.2.2.3 Number of children (as defined in 5.3.2.2.2) that perform regular work.	**Quantitative** (See Annex G for detailed description) Number	Employment records Copies of working contracts
5.3.2.2.4 Number of children (as defined in 5.3.2.2.2) that perform light work.	**Quantitative** (See Annex G for detailed description) Number	Employment records Copies of working contracts
5.3.2.3.1 Describe how legally granted collective bargaining rights are addressed, including non-interference with such rights.	**Qualitative** Description of information and reference to documentation	Information provided by trade unions, staff associations, workers councils or similar organizations Records of internal policies Reference to the applicable law
5.3.2.4.1 Number and percentage of employees covered by a legally enforceable contract or equivalent document covering their wages and working conditions.	**Quantitative** Number	Employment records Copies of working contracts
5.3.2.4.2 Describe policies, procedures and practices regarding how employees are trained for the assigned work.	**Qualitative** Description of policies, procedures and practices and reference to documentation	Training records / Records of internal education for personnel Regulations in working contracts Capacity building records

Table A.2 *(continued)*

Indicator	Result	Reference/source of information/ justification
5.3.2.4.3 Describe health, safety and hygiene policies, procedures and practices.	**Qualitative** Description of policies, procedures and practices and reference to documentation	
5.3.2.4.4 Describe policies, procedures and practices related to discrimination.	**Qualitative** Description of policies, procedures and practices and reference to documentation	Records of internal policies Records of internal communication Records of worker exposure campaigns Reference to applicable law
5.3.2.4.5 Percentage of employees who have been trained as described in each of 5.3.2.4.3 and 5.3.2.4.4.	**Quantitative** Number	Training records / Records of internal education for personnel
Land use rights and land use change		
5.3.3.1.1 Where traditional land use rights are applicable, is there documented evidence of a process for consulting and gaining free, prior and informed consent for the right to use the land, and documented evidence of the outcomes?	**Binary** Yes/No	Geographically referenced lists of participating communities and individuals Documentation of stakeholder consultation process Reference to land title documents
5.3.3.1.2 Where the competent national authority has determined that there are direct effects on local food security from land use change resulting from the process being assessed, is there evidence of free, prior and informed consent from local stakeholders?	**Binary** Yes/No	Geographically referenced lists of participating communities and individuals Documentation of stakeholder consultation process including consent and unresolved disputes
5.3.3.1.3 Where local stakeholder consent has been sought under 5.3.3.1.2., describe the area considered to be local and the process to determine that area.	**Qualitative** Geographic information Process for determining area to be considered local	Records of land ownership Supply structures for food and their spatial extension Survey of accessibility via land and water bodies
Water use rights		
5.3.4.1.1 Describe procedures applied to identify potential impacts on water availability within the affected local community, including the impacts on water quantity and quality for human consumption and food production.	**Qualitative**	Survey of accessibility to water bodies Data from assessment under 5.2.2 on Water Reporting and application provided to authorities Impact assessments EIA Environmental impact assessment
5.3.4.1.2 Describe the process to determine the affected local community.	**Qualitative** Geographic information Process for determining area to be considered local	Records of land and water use rights ownership Geographical extent of the area
5.3.4.1.3 List the potential impacts that were identified by applying the procedures under 5.3.4.1.1.	**Qualitative** List of impacts	Environmental impact assessment (EIA) Data from assessment under 5.2.2 on Water
5.3.4.1.4 Describe the process for consulting and gaining free, prior and informed consent from local stakeholders on water availability.	**Qualitative**	Documentation of stakeholder consultation process including consent and unresolved disputes Documentation of stakeholder consultation outcome

Table A.2 *(continued)*

Indicator	Result	Reference/source of information/ justification
5.3.4.1.5 Describe measures taken, including policies, procedures and practices, to address the potential impacts listed under 5.3.4.1.3.	**Qualitative** Introduction of appropriate technology	Data of water availability over time Data of economic operator water use over time Records of water management by economic operator Monitoring data on water withdrawal Data from assessment under 5.2.2.1.4 on Water
Economic indicators		
Economic sustainability		
5.4.1.1.1 Does the economic operator have procedures to identify potential issues regarding fraudulent, deceptive or dishonest commercial business and consumer practices?	**Binary** Yes/No	Describe examples of procedures to identify potential issues regarding fraudulent, deceptive, or dishonest commercial business and consumer practices
5.4.1.1.2 Can the economic operator describe the measures taken to address identified issues regarding fraudulent, deceptive or dishonest commercial business and consumer practices identified by applying the procedures under 5.4.1.1.1?	**Binary** Yes/No	Describe examples of measures taken addressing fraudulent, deceptive, or dishonest commercial business and consumer practices
5.4.1.1.3 Can the economic operator describe key parameters, assessments or metrics used to characterize the effect of measures taken under 5.4.1.1.2?	**Binary** Yes/No	Annual reports Corporate Social Responsibility (CSR) reports Independent reports Other parameters identified by the supplier
5.4.1.2.1 Does the economic operator have procedures to identify potential financial risks?	**Binary** Yes/No	Describe examples of financial risk identification procedures
5.4.1.2.2 Can the economic operator describe the measures taken to address financial risks that were identified by applying the procedures under 5.4.1.2.1?	**Binary** Yes/No	Describe examples of measures taken addressing financial risks
5.4.1.2.3 Can the economic operator describe key parameters, assessments or metrics used to characterize the effect of measures taken under 5.4.1.2.2?	**Binary** Yes/No	Annual reports CSR reports Independent reports Other parameters identified by the supplier Credit rating

Annex B
(informative)

Guidance related to water indicators

B.1 General

This annex provides examples for additional information and guidance to the economic operator and other users of this International Standard to understand and respond to indicators 5.2.2.1.1 to 5.2.2.1.5.

The examples provided in this annex are not a comprehensive list.

Some indicators may be wholly or partly covered by relevant legal requirements, national regulations or recognized best practice. The information in this annex should be considered in the context of undue administrative or economic burden for an economic operator.

B.2 Guidance on indicator 5.2.2.1.1

5.2.2.1.1 Indicator: Describe procedures applied to identify potential impacts on water quantity including consideration of water depletion and other key chemical, physical and/or biological parameters. Describe procedures applied to identify potential impacts on water quality, including consideration of eutrophication and oxygen depletion and other key chemical, physical and/or biological parameters. Impacts to water quantity and quality shall be addressed with respect to water sources and receiving bodies.

In responding to indicator 5.2.2.1.1, the economic operator should provide a reference to the recognized procedures that were followed and/or provide a detailed description of what other procedures were followed, for example:

— carried out water quantity (availability assessment) and quality testing (analysis) in accordance with the method established by [insert name of internationally recognized body or government authority and dated publication reference];

— potential impacts were identified from the water conservation plan [insert dated publication reference] published by [insert reference to name of competent authority];

— potential impacts were identified from the environmental impact assessment report [insert dated publication reference] published by [insert reference to name of competent third party];

— followed a stepwise procedure with detailed account of accepted methodology, i.e. consulted with [insert name of competent authority], performed a field survey to identify taking and receiving bodies, collected water withdrawal data from past 12 months, collected groundwater elevation data from withdrawal well for past 12 months, evaluated turbidity measurements in receiving body, etc.

NOTE When identifying potential impacts consider both normal operations and incidents where appropriate.

B.3 Guidance on indicator 5.2.2.1.2

5.2.2.1.2 Indicator: List the impacts from water withdrawals on water sources identified by applying the procedures under 5.2.2.1.1.

In responding to indicator 5.2.2.1.2, the economic operator should include a list of the relevant impacts identified in the procedures in indicator 5.2.2.1.1, for example:

— water depletion;

— changes in water flow regimes or levels, considering periodicity;

— changes in availability of irrigation water for existing downstream users;

— change in a key functional attribute, e.g. turbidity, salinity, temperature.

B.4 Guidance on indicator 5.2.2.1.3

5.2.2.1.3 Indicator: List the impacts from water releases on the receiving body as identified by applying the procedures under 5.2.2.1.1.

In responding to indicator 5.2.2.1.3, the economic operator should include a list of the impacts identified in the procedures in indicator 5.2.2.1.1, for example:

— change in assimilative capacity;

— change in water temperature;

— change in water flows or levels;

— change in volumetric load to sewage treatment plant;

— eutrophication;

— oxygen depletion;

— change in sedimentation.

B.5 Guidance on indicator 5.2.2.1.4

5.2.2.1.4 Indicator: Describe measures taken to address the identified impacts identified in 5.2.2.1.2 and 5.2.2.1.3.

In responding to indicator 5.2.2.1.4, the economic operator should include the measures taken to address the relevant net impacts listed in indicators 5.2.2.1.2 and 5.2.2.1.3, for example:

— install new wellhead for downstream community;

— restrict water taking during low flow conditions;

— install overflow dams to balance water flows;

— remove phosphorous using [insert name of treatment process];

— remove oxidizable organic materials using [insert name of treatment process].

B.6 Guidance on indicator 5.2.2.1.5

5.2.2.1.5 Indicator: Report the absolute or net value of key parameters or metrics used to measure the effect of addressing the impacts identified in 5.2.2.1.2 and 5.2.2.1.3.

In responding to indicator 5.2.2.1.5, the economic operator should report metrics to provide information on the effectiveness of the measures taken, over a relevant time period (e.g. one rotation period), in indicators 5.2.2.1.2 and 5.2.2.1.3:

The reported metrics can be expressed in absolute values. In addition, trends can be depicted over a timeline and/or change in percentage. Relevance of a measurement in the context of the respective operation of the bioenergy process should be explained.

Results of each test, measurement or evaluation should be derived from methods (e.g. ISO standards, ASTM standards; see Table B.1), data from competent bodies or government authorities, or through

other practicably appropriate means. Reported values may be compared to accepted values for the particular geographic/locale of the bioenergy process(es).

Below are some indicative examples of metrics and units that can be used in answering this indicator.

Example units for metrics depend on the intention of documentation and scope of comparison.

a) Measurement and monitoring data in accordance with 4.9 that allow assessment of potential impacts on water bodies, groundwater:

   — mg/L, ppm (monitoring of concentrations in effluents, receiving bodies, groundwater, etc.);

   — m^3/day (monitoring of withdrawal from water bodies, groundwater or release to water bodies and treatment plants);

   — m (monitoring of groundwater level);

   — °C (temperature):

   — pH.

b) Calculation of mass or volume flow based on measurements in item 1 above that allows monitoring of total impacts of total releases or withdrawals:

   — g/day (total release at a site);

   — m^3/day (total withdraw or release at a site).

c) Calculation per process output that allows analysis of emissions and flows per process:

   — g/kg product (emission on a process level);

   — m^3/kg product (inflow or outflow on a process level).

d) Calculation per functional unit that allows comparison of life cycle result of bioenergy products, e.g. see 6.5 on functional units:

   — g/unit of bioenergy produced (total emissions in the life of bioenergy products);

   — m^3/unit of bioenergy produced (total water consumption in the life cycle of bioenergy product);

   — $kg_{equivalents}$ of substance xyz/unit of bioenergy produced (category indicator results according to [insert reference to publication of characterization factors]).

Table B.1 — Example test methods for key parameters and metrics — Water

Key parameters or metrics	Example test methods[a]	Additional information on why this metric is relevant
Consumptive water use	Pump curve or weir	Key parameter for water depletion (driving force)
Quantity of effluents		Relevant to relativizing consumption → continuous flow; (not relevant from a quality perspective)
Groundwater level		Monitoring
Minimum base flow		Monitoring
Phosphorus	ISO 15681-2:2003	Key parameter for eutrophication (includes all types of P compounds)
Nitrogen	ISO 29441:2010	Key parameter for eutrophication (includes all types of N compounds)
Nitrate	ISO 7890-3:1988	Relevant parameter for eutrophication and ecotoxicity
Biological oxygen demand (BOD)	ISO 10707:1994	Key bulk parameter for oxygen depletion
Chemical oxygen demand (COD)	ISO 6060:1989	Key bulk parameter for oxygen depletion
Total organic carbon (TOC)	ASTM D7573–09 ASTM D5904–02 (2009)	Relevant bulk parameter for organic load (widely overlapping with BOD)
Total suspended solid concentration	ASTM D5907-13	Sampling parameter for material burden
Total dissolved solid concentration	ASTM D5907-13	Sampling parameter for material burden
Absorbable organic halogens (AOX)	ISO 9562:2004	Screening parameter for organic water pollutants
Pesticide concentrations	ISO 15913:2000 ASTM D5659-14 A-A-197	Relevant ecotoxicological parameter for export from agriculture to water bodies Incidences could lead to hazardous exposures for the population
Heavy metals such as cadmium, chromium, copper, mercury, nickel and / or zinc	ISO 8288:1986 ISO 5961:1994 ISO 13163:2013 ASTM D3557-12 ASTM D3559-08	Relevant toxicological parameters and contaminants of mineral P-fertilizer (Eco)toxicological parameters of industrial sources, mining, fertilizer production and application Copper is used as a pesticide
Radioactive species, nuclides, unspecified		Relevant toxicological parameter, mineral P-fertilizer or industrial sources for bioenergy systems
pH, acidity or alkalinity	ASTM D5128–14	Parameter for process effluents; only relevant in specific cases
Temperature increase or heat load		Parameter for discharge of cooling water
Microbiological analyses	Standard Methods for the Examination of Water and Wastewater, 20th Edition, 1998, and 21st Edition, 2005, American Public Health Association, American Waterworks Association (AWWA), Water Environmental Federation	E.coli, coliform, etc.
Biological surveys	ISO 8689-1:2000 ISO 8689-2:2000	Growth of algae Macro-zoobenthon as indicators for flowing water quality
Water footprint	ISO 14046:2014	Water footprint calculated in accordance with ISO 14046 and using method [provide reference] for characterization of water flows.

[a] Any applicable international or domestically acceptable test methodology, such as those approved as International Standards, or other international or national norms/standards.

Annex C
(informative)

Guidance related to soil indicators

C.1 General

This annex provides examples for additional information and guidance to the economic operator and other users of this International Standard to understand and respond to indicators 5.2.3.1.1 to 5.2.3.1.6.

The examples provided in this annex are not a comprehensive list.

Some indicators may be wholly or partly covered by relevant legal requirements, national regulations or recognized best practice. The information in this annex should be considered in the context of undue administrative or economic burden for an economic operator.

C.2 Guidance on indicator 5.2.3.1.1

5.2.3.1.1 Indicator: Describe procedures applied to identify potential impacts on soil quality and productivity, including consideration of organic carbon, nutrients, water holding capacity, and other key chemical, physical and/or biological parameters, as well as salinization.

In response to indicator 5.2.3.1.1, the economic operator should provide a reference to the recognized procedures that were followed and/or provide a detailed description of what other procedures were followed, for example:

— carried out soil testing in accordance with the method established by [insert name of internationally recognized body or government authority and dated publication reference];

— potential impacts were identified from the soil conservation plan [insert dated publication reference] published by [insert reference to name of competent authority];

— potential impacts were identified from the environmental impact assessment report [insert dated publication reference] published by [insert reference to name of competent third party];

— followed a stepwise approach with detailed account of accepted methodology, i.e. consulted with [insert name of competent authority], performed a field survey on physical soil disturbance, used a mass balance approach to estimate soil carbon and nutrient losses and description of each subsequent step.

NOTE 1 When identifying potential impacts consider both normal operations and incidents where appropriate.

C.3 Guidance on indicator 5.2.3.1.2

5.2.3.1.2 Indicator: List impacts on soil quality and productivity that were identified by applying the procedures under 5.2.3.1.1.

In responding to indicator 5.2.3.1.2, the economic operator should include a list of the impacts identified using the procedures in indicator 5.2.3.1.1, for example:

— change in organic carbon;

— change in nutrients;

— salinization;

— change in water-holding capacity;

— compaction;

— contamination;

— change in buffering capacity;

— acidification;

— change in microflora and microfauna;

— others.

C.4 Guidance on indicator 5.2.3.1.3

5.2.3.1.3 Indicator: Describe measures taken to address soil quality (chemical, physical and biological) and productivity impacts as identified in 5.2.3.1.2.

In responding to indicator 5.2.3.1.3, the economic operator should describe measures taken to address soil quality and productivity impacts listed in indicator 5.2.3.1.2, for example:

— spill containment, e.g. chemicals;

— prevent contaminant leaching, e.g. biomass storage;

— maintain soil permeability and promote aeration (e.g. through drainage measures or gypsum amendment) in non-porous soils;

— adhere to residue retention levels according to [name of competent body or standard] or addition of cover crops;

— change field management practices (e.g. tillage, fertilization) and timing and/or rotations;

— water management practices;

— counteract nutrient loss and buffering capacity loss with fertilizer, recycled wood ash and/or leaving nutrient-rich logging residues;

— reduce soil compaction/disturbance by leaving logging residues (or other mechanical protection) in strip roads or by performing harvest and transport when the soil is dry or frozen;

— apply adapted soil management practices (e.g. ground water management in peat soils);

— others.

The measures taken should cover the relevant time period (see 4.7).

NOTE 2 Existing best management practices/guidelines (e.g. for land clearance and establishment, harvest intensity, regeneration) [insert reference to name of competent authority] can be used as a source for measures.

C.5 Guidance on indicator 5.2.3.1.4

5.2.3.1.4 Indicator: Describe procedures applied to identify the potential drivers of soil erosion including potential erosion resulting from rainfall, runoff and/or wind.

In responding to indicator 5.2.3.1.4, the economic operator should reference established, recognized procedures that were followed or provide a more detailed account of what was done, for example:

— conducted a soil erosion assessment in accordance with the method established by [insert name of internationally recognized body or government authority and dated publication reference];

— potential soil erosion drivers were identified from the environmental impact assessment report [insert dated publication reference] published by [insert reference to name of competent third party].

C.6 Guidance on indicator 5.2.3.1.5

5.2.3.1.5 Indicator: List drivers of soil erosion as identified in 5.2.3.1.4 and describe measures taken to address them.

In responding to indicator 5.2.3.1.5, the economic operator should list whether precipitation and/or wind are relevant soil erosion drivers that were identified using the procedures described in indicator 5.2.3.1.4 and measures to address them, for example:

— terrace;

— perennial buffer strips;

— windbreaks;

— design road network to manage erosion risk;

— change in field management practices such as switching implements and/or the timing of operations;

— adjust residue removal rates;

— alter crop sequence within a rotation;

— avoid stream crossings without proper means of stream protection (bridge);

— buffer strips along riparian zones;

— apply best management practices/guidelines [insert dated publication reference] suggested by [insert reference to name of competent authority].

The measures taken should cover the relevant time period (see 4.7).

C.7 Guidance on indicator 5.2.3.1.6

5.2.3.1.6 Indicator: Report the values and trends of key chemical, physical and biological parameters or metrics used to measure the effect of addressing the impacts identified in indicator 5.2.3.1.2 and the drivers identified in indicator 5.2.3.1.5.

In responding to indicator 5.2.3.1.6, the economic operator should report on metrics to provide information on the effectiveness of the measures taken, over a relevant time period (e.g. one rotation period in forestry, three rotation periods in conventional short-rotation systems), in indicators 5.2.3.1.2 and 5.2.3.1.5, for example:

Economic operators can use the statements below and put in their own data for x, y, z, etc.

— (In the case of a soybean/corn crop rotation) the relevant time period for this short-rotation crop was decided to be 3 years to represent 3 crop rotations. The metrics chosen over this time period were x, y and z, and the values measured are as follows:

— x year 1 =

— x year 2 =

— x year 3 =

— (in the case of wood biomass) the relevant time period for this long-rotation biomass was decided to be xx years to represent 1 rotation. The metrics chosen over this time period were x, y and z, and the values measured are as follows:

— x year a =

— x year b =

— x year *n* =

The reported metrics can be expressed in absolute values. In addition, trends can be depicted over a timeline and/or change in percentage. Relevance of a measurement in the context of the respective operation of the bioenergy system should be explained.

Results of each test, measurement or evaluation should be derived from methods (e.g. ISO standards, ASTM standards; see Table C.1), data from competent bodies or government authorities, or through other practicably appropriate means. Reported values may be compared to accepted values for the particular geographic locale of the bioenergy crop production.

Below are some indicative examples of metrics and units that can be used in answering this indicator.

Example units for metrics depend on the intention of documentation and scope of comparison.

a) Measurement and monitoring data in accordance with 4.9 that allow assessment of potential impacts on soil:

   — kg/kg soil (organic carbon);

   — kg (application of nutrients);

   — pH.

b) Calculation of mass/time or mass/area based on measurements in item 1 above:

   — Mg/ha/year (soil erosion);

   — kg/ha (concentration of nutrients).

c) Calculation per process output that allows analysis of emissions and flows per process:

   — g/kg product (comparison on process level) (e.g. gram phosphate applied/kg biomass).

d) Calculation per functional unit that allows comparison of life cycle result of bioenergy products, e.g. see 6.5 on functional units:

   — g/unit of bioenergy produced (comparison of bioenergy products);

   — $kg_{equivalents}$ of substance xyz/unit of bioenergy produced (category indicator results according to [insert reference to publication of characterization factors]).

Table C.1 — Example test methods for key parameters and metrics — Soil

Key parameters or metrics	Example test methods[a]	Additional information on why this metric is relevant
Organic carbon	ASTM D2974-14	
Nitrogen	ISO 14255:1998	
Phosphorus		
Potassium		
Buffering capacity		
pH	ISO 10390:2005 ASTM D4972-13	
Salinization		
Bulk density		
Water holding capacity		
Erosion/soil loss	ASTM D6629-01(2012) e1	
Micro flora and fauna		
Heavy metals (e.g. Cd, Hg, …)		
Organic pollutants (PAH, Benzene, Dioxine, …)		
Human toxicity, non-cancer effects (CTUh/unit of bioenergy)	ILCD method[64]	Category indicator example used for characterization of soil emissions in LCA.

NOTE 1 For low-intensity production systems with long relevant time periods as in long-rotation forestry, empirical data will not be available at the production site level, but rather on the regional or national level.

NOTE 2 Any contaminants reported in this table should be relevant to a site-specific assessment.

NOTE 3 Most common soil contaminants include petroleum hydrocarbons, solvents, pesticides, lead and other heavy metals.

[a] Any applicable international or domestically acceptable test methodology such as those approved as International Standard, or other international or national norms/standards

Annex D
(informative)

Guidance related to air indicators

D.1 General

This annex provides examples for additional information and guidance to the economic operator and other users of this International Standard to understand and respond to indicators 5.2.4.1.1 to 5.2.4.1.4.

The examples provided in this annex are not a comprehensive list.

Some indicators may be wholly or partly covered by relevant legal requirements, national regulations or recognized best practice. The information in this annex should be considered in the context of undue administrative or economic burden for an economic operator.

D.2 Guidance on indicator 5.2.4.1.1

5.2.4.1.1 Indicator: Describe procedures applied to identify potential air emission sources and contaminants having impacts including consideration of sulfur oxides (SO_x), nitrogen oxides (NO_x), particulate matter (PM), volatile organic compounds (VOC), carbon monoxide (CO), ammonia (NH_3) and heavy metals.

In responding to indicator 5.2.4.1.1, the economic operator should provide a reference to the recognized procedures that were followed and/or provide a detailed description of what other procedures were followed, for example:

— carried out air impact assessment in accordance with the method established by [insert name of internationally recognized body and dated publication reference];

— performed air impact assessment in accordance with [insert name of government authority, publication reference];

— potential impacts were identified from the impact assessment report [insert dated publication reference] published by [insert reference to name of competent authority]; or

— followed a stepwise procedure (e.g. performed a survey of air emission sources and contaminants; measured/determined emission levels; calculated point of reception concentrations; identified applicable air quality standards, compared point of reception values to published standards and described subsequent steps.).

D.3 Guidance on indicator 5.2.4.1.2

5.2.4.1.2 Indicator: List potential air emission sources, emission rates and impacts that were identified by applying the procedures under 5.2.4.1.1.

In response to indicator 5.2.4.1.2, the economic operator should provide a list of each source, rate and impact in text or tabular format as follows, for example:

— fuel combustion emission (e.g. NO_x, SO_2, CO, Hg, PM_{10}, $PM_{2.5}$, acrolein, benzo-a-pyrene);

— tractors, seeders, planters and other equipment (e.g. emissions from fuel burning);

— open-air burning (e.g. PM_{10}, $PM_{2.5}$, NO_x);

— pesticides, manure and fertilizers (e.g. NH_3, dust);

— leakages from biogas plant (e.g. ammonia);

— noise levels from processing plant (e.g. dB(A)).

NOTE Greenhouse gas emissions (e.g. emissions from soil) are covered by 5.2.1.

Table D.1 is an example of a response to indicator 5.2.4.1.2.

Table D.1 — Example of response to indicator 5.2.4.1.2

Substance	Source	Emission rate	Impact (point of reception concentration)	Comments
NO_x	Boilers 1, 2, 3	0,6 g/s	10 µg/m³; 24-hr point of reception 25 µg/m³l; annual point of reception	Complies with standard
NH_3	Anhydrous ammonia fertiliser	1,5 g/s	3 600 µg/m³; 1-hr point of reception	Complies with standard
NO_x	Open-air burning (agricultural vehicle emissions deemed not relevant to vehicle emission standards)	0,8 g/s	10 µg/m³; 24-hr point of reception 25 µg/m³l; annual point of reception	Complies with standard
SO_2	Boilers 1, 2, 3	Value	Value	Complies with standard
CO	Boilers 1, 2, 3	Value	Value	Complies with standard
Hg	Boilers 1, 2	Value	Value	Complies with standard
PM_{10}	Boilers 1, 2, 3	Value	Value	Complies with standard
$PM_{2,5}$	Boilers 1, 2, 3	Value	Value	Complies with standard
Acrolein	Boilers 1, 2, 3	Value	Value	Complies with standard
Benzo-a-pyrene	Boilers 1, 2	Value	0,8 µg/m³	Exceeds this carcinogen-based standard by 1,3 %

These emission sources were measured and comply with the [insert name of the applicable national air quality standards] except for benzo-a-pyrene, which is a known carcinogen. This substance exceeds the national standard by 1,3 % on an annual basis.

D.4 Guidance on indicator 5.2.4.1.3

5.2.4.1.3 Indicator: Describe the measures taken to address identified air emissions and impacts listed under 5.2.4.1.2.

In responding to indicator 5.2.4.1.3, the economic operator should provide and describe the measures taken to address the impacts listed in indicator 5.2.4.1.2, for example:

No additional measures were taken for most emissions; however, the levels of all emissions are constantly reviewed with the intent of continuous improvement. Efforts to reduce emissions of benzo-a-pyrene include: a compliance abatement agreement with the [insert the name of applicable authorities]; ongoing studies to identify less BaP-emitting coal sources; low-temperature fluidized bed technologies; and advanced $PM_{2,5}$ emission capture technologies.

D.5 Guidance on indicator 5.2.4.1.4

5.2.4.1.4 Indicator: Report the value and trends of key parameters or metrics used to measure the effect of addressing the impacts identified in indicator 5.2.4.1.2.

In responding to indicator 5.2.4.1.4, the economic operator should report metrics to provide information on the effectiveness of the measures taken, over a relevant time period (e.g. one rotation period), in indicator 5.2.4.1.3.

The reported metrics can be expressed in absolute values. In addition, trends can be depicted over a timeline and/or change in percentage. Relevance of a measurement in the context of the respective operation of the bioenergy system should be explained.

Results of each test, measurement or evaluation should be derived from methods (e.g. ISO standards, ASTM standards; see Table D.2), data from competent bodies or government authorities, or through other practicably appropriate means. Reported values may be compared to accepted values for the particular geographic/locale of the bioenergy crop production.

Below are some indicative examples of metrics and units that can be used in answering this indicator.

Example units for metrics depend on the intention of documentation and scope of comparison.

a) Measurement and monitoring data in accordance with 4.9 that allow assessment of potential impacts on population and the environment:

   — g/s, ppm (rate of emission of BaP, NO_x);

   — µg/Nm^3 ($PM_{2.5}$);

   — Nm^3/day (monitoring of total exhaust gas emissions).

b) Calculation of mass or volume flow based on measurements in item 1 above that allows monitoring of total impacts of total releases or depositions:

   — g/day (total deposition at a site);

   — kg/day (total emission per day).

c) Calculation per process output that allows analysis of emissions and flows per process:

   — g/kg product (emission on a process level).

d) Calculation per functional unit that allows comparison of life cycle result of bioenergy products, e.g. see 6.5 on functional units:

   — g/unit of bioenergy produced (total emissions in the life of bioenergy products);

   — $kg_{equivalents}$ of substance xyz/unit of bioenergy produced (category indicator results according to [insert reference to publication of characterization factors]).

Table D.2 — Examples test methods for key parameters and metrics — Air

Key parameters or metrics	Example test methods[a]	Additional information on why this parameter is relevant
NO_x	ISO 7996:1985 ISO 10849:1996	Usually a key parameter for combustion emissions and air quality
SO_2	ISO 10498:2004	Usually a key parameter for fossil fuel combustion emissions and air quality
CO	ISO 8186:1989 ISO 8760:1990	Usually a key parameter for combustion and air quality
Mercury	ISO 17733:2004	Relevant parameter for specific operations
PM_{10}	ISO 9096:2003 ISO 13271:2012	Usually a key parameter for air quality
$PM_{2.5}$	ISO 13271:2012	Usually a relevant parameter for air quality
Acrolein		Relevant parameter from burning of Crude glycerol (a by-product from biodiesel production)
Benzo-a-pyrene		Relevant parameter for specific operations, mainly with wood or coal burning
Particulate matter/unit of bioenergy	ILCD method[64]	Category indicator example used for characterization of soil emissions in LCA.

NOTE Any contaminants reported in the table above should be relevant to a site-specific assessment.

[a] Any applicable international or domestically acceptable test methodology such as those approved as International Standard, or other international or national norms/standards.

Annex E
(informative)

Guidance related to biodiversity indicators

E.1 General

This annex provides examples for additional information and guidance to the economic operator and other users of this International Standard to understand and respond to indicators 5.2.5.1.1 to 5.2.5.2.4.

The examples provided in this annex are not a comprehensive list.

Some indicators may be wholly or partly covered by relevant legal requirements, national regulations, or recognized best practice. The information in this annex should be considered in the context of undue administrative or economic burden for an economic operator.

E.2 Examples – biodiversity within the area of operation

E.2.1 Guidance on indicator 5.2.5.1.1

5.2.5.1.1 Indicator: Describe procedures applied to identify potential impacts on biodiversity, including ecosystems, habitats and identified rare, threatened and vulnerable species of local, regional or global importance, including information about restrictions on the activities due to biodiversity protection purposes.

In response to indicator 5.2.5.1.1, the economic operator should provide a reference to the recognized procedures that were followed and/or provide a detailed description of what other procedures were followed, for example:

— carried out biodiversity impact assessment in accordance with the method established by [insert name of recognized body and dated publication reference];

— potential impacts were identified from the biodiversity conservation plan [insert dated publication reference] published by [insert reference to name of competent authority];

— potential impacts were identified from the inventory of threatened ecosystems, habitats and/or identified rare, threatened and vulnerable species [insert dated publication reference] published by [insert reference to name of competent authority];

— potential impacts were identified from the environmental impact assessment report [insert dated publication reference] published by [insert reference to name of competent third party]; or

— stepwise approach with detailed account of accepted methodology, i.e. consulted with [insert name of competent authority]; prepared an inventory of threatened ecosystems, habitats and/or identified rare, threatened and vulnerable species; performed a field survey to verify ecosystems, habitats and/or species of potential concern; assessed potential impacts of site activities on existing ecosystems, habitats and/or species; and described each subsequent step.

NOTE Biodiversity conservation is an area where the policy strategies might matter. It can therefore be useful for the assessment to report on the relevant policy strategies, i.e. if the conservation strategy includes large areas of set aside land with more intense production systems in the area of production, or if production takes place in most areas and biodiversity is to be maintained within the area of production.

E.2.2 Guidance on indicator 5.2.5.1.2

5.2.5.1.2 Indicator: List the potential impacts on biodiversity that were identified by applying the procedures under 5.2.5.1.1.

In response to indicator 5.2.5.1.2, the economic operator should include a list of the relevant impacts identified in the procedures in indicator 5.2.5.1.1, for example:

— change in habitat and ecosystem diversity, e.g. through ploughing of grassland, woodlot removal, clearance of forests, drainage of wetlands and other measures to expand the area of production;

— change in hydrology, e.g. through drainage or change in water quality, e.g. through eutrophication, pollution and other changes in conditions for aquatic species;

— change in crop or tree species composition, e.g. due to changes in crop rotation cycles and fallow periods, or introduction or elimination of crops and trees and their associated biodiversity value;

— fragmentation of habitats;

— change in management intensification, e.g. number and timing of mowing during mating/breeding season, manuring of grassland, pesticide and fertilizer application and harvest of logging residues and stumps;

— change in important structures, e.g. volume of dead wood, abundance of old and cavity trees, hedges and field margins;

— introduction of alien species, genetically modified crops and potentially invasive species;

— change in the population of identified rare, threatened and vulnerable species pointed out to be of local, regional or global importance.

E.2.3 Guidance on indicator 5.2.5.1.3

5.2.5.1.3 Indicator: Describe measures taken to address biodiversity impacts identified in 5.2.5.1.2, including those measures addressing biodiversity protection restrictions.

In response to indicator 5.2.5.1.3, the economic operator should describe measures taken to address impacts on biodiversity listed in indicator 5.2.5.1.2, for example:

— increase ecosystem and habitat diversity:

— establish or restore important structures such as hedges, field margins, buffer zones, key (stepping stone) habitats and aquatic habitats (i.e. a small pond);

— increase crop/tree diversity, especially of those associated with high biodiversity values;

— increase important structures, e.g. volume of dead wood, abundance of old trees and cavity trees, hedges and field margins.

— reconnect fragmented habitats;

— establish or restore waterways to allow for movements, breeding and spawning of amphibians and fish;

— avoid harvest and tilling during mating/breeding season;

— abstain from manuring biodiverse grasslands;

— change pesticide and/or fertilizer regimes, e.g. intensity, integrated pest management or ecological management of pests and nutrients such as push and pull crops, intercropping, etc.;

— avoid the cropping of potentially invasive species;

— contain the cropping of alien species and genetically modified crops;

— apply measures to promote a viable population of the identified rare, threatened or vulnerable species of local, regional or global importance according to [insert reference];

— use best management practices/guidelines [insert dated publication reference] suggested by [insert reference to name of competent authority].

E.2.4 Guidance on indicator 5.2.5.1.4

5.2.5.1.4 Indicator: Report the value of key parameters or metrics used to measure the effect of addressing the impacts identified in indicator 5.2.5.1.2.

In response to indicator 5.2.5.1.4, the economic operator should report metrics, figures or descriptions to provide information on the effectiveness of the measures taken, over a relevant time period, for example:

— change in area of set-aside land (nature reserves, key (stepping stone) habitats, buffer zones, hedges, etc.);

— change in volume of living and dead wood left to promote biodiversity (m^3 per ha);

— change in habitats important for targeted identified rare, threatened or vulnerable species (number, area, volume);

— change in habitat diversity (mapped area of wetlands, fields, forests, surface waters, etc.);

— monitoring report showing population size and/or trend for the targeted identified rare, threatened and vulnerable species.

NOTE The selection of appropriate key parameters depends on the particular measures taken to address potential impacts on biodiversity as stated in indicator 5.2.5.1.3.

E.3 Examples – biodiversity protected areas

The indicators under 5.2.5.2 are only applicable for biomass removal from those areas designated as biodiversity protected areas under applicable national laws and regulations within IUCN categories I to III.

Typical cases could be:

— when an invasive species has to be removed to maintain or strengthen biodiversity;

— when natural regeneration of trees has to be removed to maintain or strengthen biodiversity in protected open landscapes;

— when the amount of biomass has to be reduced to decrease risk for forest fires;

— when biomass has to be removed to decrease nutrients.

In response to indicator 5.2.5.2.1 the economic operator provides a map of the location of the designated biodiversity-protected area where biomass removal is allowed, showing the location and area of the designated protected area (ha) (including contiguous and non-contiguous parts of the designated protected area).

In response to indicator 5.2.5.2.2 the economic operator provides a map showing the location of the designated biodiversity-protected area where biomass removal is allowed; and the area where the economic operator removes biomass.

In response to indicator 5.2.5.2.3 the economic operator describes how the biomass removed by the economic operator impacts (positively or negatively) the biodiversity goals of the protected area and

directly influenced environment including information on e.g. type of removed biomass and quantities, as prescribed by management authorities.

In response to indicator 5.2.5.2.4 the economic operator lists and documents permits obtained from the management authorities for operations in the protected areas.

Annex F
(informative)

Guidance related to waste indicators

F.1 General

This annex provides examples for additional information and guidance to the economic operator and other users of this International Standard to understand and respond to indicators 5.2.7.1.1 to 5.2.7.1.6.

The examples provided in this annex are not a comprehensive list.

Some indicators may be wholly or partly covered by relevant legal requirements, national regulations or recognized best practice. The information in this annex should be considered in the context of undue administrative or economic burden for an economic operator.

F.2 Guidance on indicator 5.2.7.1.1

5.2.7.1.1 Indicator: Describe procedures applied to identify potential impacts of generated wastes on human health and the environment.

In response to indicator 5.2.7.1.1, the economic operator should provide a reference to the recognized procedures that were followed and/or provide a detailed description of what other procedures were followed, for example:

— prepared a waste management plan;

— developed the environmental impact assessment report for new developments;

— conducted a waste assessment in accordance with the method established by [insert name of internationally recognized body and dated publication reference];

— prepared a soil conservation assessment that specifically addresses waste disposal [insert dated publication reference] published by [insert reference to name of competent authority];

— followed other identified procedures to classify different groups of waste into non-concern and concern categories;

— used an assessment that followed country or regional guidelines (EU, ASEAN, NAFTA guidelines);

— followed a stepwise procedure (e.g. conducted a waste audit, classified waste materials by hazard type and disposal method, determined potential exposure pathways, etc.).

Possible areas of concern that could be addressed under a procedure to identify waste-driven impacts include, for example:

— eutrophication due to runoff or leaching;

— reduced water quality, including changes in salinity;

— loss of biodiversity due to contamination or toxicity;

— health impacts due to contamination of air through open air burning or incineration of waste materials;

— contamination of storm water;

— contamination of water resources by untreated vinasse / (stillage).

F.3 Guidance on indicator 5.2.7.1.2

5.2.7.1.2 Indicator: List potential impacts of wastes generated that were identified by applying the procedures under 5.2.7.1.1.

In responding to indicator 5.2.7.1.2, the economic operator should include a list of the relevant impacts identified in the procedures in indicator 5.2.7.1.1, for example:

— odour;

— impacts on disease potentials in impact areas;

— contamination of soil, ground and surface water or air, by generated waste that is not already included in other relevant indicators;

— changes in the cropping parameter of areas due to waste contamination;

— losses of biodiversity due to waste contamination not otherwise included in the biodiversity indicators.

F.4 Guidance on indicator 5.2.7.1.3

5.2.7.1.3 Indicator: Describe the measures taken to address potential impacts identified in 5.2.7.1.2, including handling, separation, storing, reusing, recycling, recovering and disposal.

In responding to indicator 5.2.7.1.3, the economic operator should include the measures taken to address the relevant impacts listed in indicator 5.2.7.1.2, for example:

— compost;

— use anaerobic digestion to produce biogas;

— train workforce to manage waste properly;

— prepare awareness programs;

— designate storage areas for waste disposal;

— promote correct use of containers and empty bulks for reuse or recycling;

— dispose waste in appropriate containers;

— implement manufacturer's recommended disposal options;

— infrastructure design elements and strategies used to integrate the necessary operations for safe burning of processing waste;

EXAMPLE For the expansion of the factory's capacity in 2012 to double its size, the design of the operation was changed, and now safe burning of process waste is possible and integrated into the energy supply.

— install facilities to reduce air pollution from waste;

— implement measurement points for contamination parameters such as air contamination or soil and water contamination;

— develop strategies to reduce waste amounts;

— develop and adopt an integrated waste management plan.

F.5 Guidance on indicator 5.2.7.1.4

5.2.7.1.4 Indicator: Report the value of key parameters or metrics used to quantify the effect of measures taken to address the impacts identified in 5.2.7.1.2.

In responding to indicator 5.2.7.1.4, the economic operator should report metrics to provide information on the effectiveness of the measures taken to manage waste impacts.

The reported metrics can be expressed in absolute values. In addition, trends can be depicted over a timeline and/or change in percentage. Relevance of a measurement in the context of the respective operation of the bioenergy system should be explained.

Results of each test, measurement or evaluation should be derived from methods (e.g. ISO standards, ASTM standards), data from competent bodies or government authorities, or through other practicably appropriate means. Reported values may be compared to accepted values for the particular geographic locale of the bioenergy crop production.

Below are some indicative examples of metrics and units that can be used in responding to this indicator.

Example units for metrics depend on the intention of documentation and scope of comparison.

a) Measurement and monitoring data in accordance with 4.9 that allow assessment of potential impacts from waste amounts:

   — mg/kg, ppm (monitoring of pollutant concentrations in waste fractions, etc.);

   — number of conducted trainings on waste management;

   — numbers of public complaints and actions taken about waste management.

b) Calculation of mass or volume flow based on measurements in item 1 above that allows monitoring of total impacts of total disposal:

   — kg/year (monitoring of waste amounts).

c) Calculation per process output that allows analysis of waste disposal per process:

   — g/kg product (waste disposal on a process level).

d) Calculation per functional unit that allows comparison of life cycle result of bioenergy products, e.g. see 6.5 on functional units:

   — g/unit of bioenergy.

Other examples of potential metrics that could be used include:

— quantity of waste effluent (BOD) produced;

— number of complaints received due to waste disposal;

— efficiency of biomass feedstock harvesting/processing operations (e.g. more efficient processing reduces waste created).

F.6 Guidance on indicator 5.2.7.1.5

5.2.7.1.5 Indicator: List the wastes that are the subject of measures described under 5.2.7.1.3 and report the annual quantities of the listed wastes generated in units of mass or volume per unit of production.

The “unit of production” can be the functional unit in accordance with 6.5 or a different measure of production described by the economic operator as more directly related to the waste.

An example table for such data is shown in Table F.1.

Table F.1 — Waste generated

Waste	Quantity
Paper	20 g/t production
Ash	1,5 kg/t production
Scrap metal	0,5 kg/t production
Palm oil milling wastes	3,8 kg/t production

F.7 Guidance on indicator 5.2.7.1.6

5.2.7.1.6 Indicator: Report separately for each waste identified in 5.2.7.1.5 the percentage that is reused, recycled, recovered or disposed.

In responding to indicators 5.2.7.1.5 and 5.2.7.1.6, the economic operator should provide a list of the annual quantities of each waste category generated, which shows separately the percentages of the waste which are reused, recycled, recovered or disposed.

An example table for such data is shown in Table F.2.

Table F.2 — Destinations of wastes generated

Waste	Tons/year	Recycled	Reused	Recovered	Disposed
Paper	1 000	85 %			15 %
Ash	50		60 %		40 %
Scrap metal	200	85 %	10 %		5 %
Palm oil milling wastes	3		50 %		50 %

Annex G
(informative)

Child labour (text from ISO 26000:2010)

G.1 General

The minimum age for employment is determined through international instruments. Organizations should not engage in or benefit from any use of child labour. If an organization has child labour in its operations or within its sphere of influence, it should, as far as possible, ensure not only that the children are removed from work, but also that they are provided with appropriate alternatives, in particular, education. Light work that does not harm a child or interfere with school attendance or with other activities necessary to a child's full development (such as recreational activities) is not considered child labour.

G.2 Child labour

ILO Conventions provide the framework for national law to prescribe a minimum age for admission to employment or work that must not be less than the age for completing compulsory schooling, and in any case not less than 15 years. In countries where economic and educational facilities are less well developed, the minimum age may be as low as 14 years. Exception may also be made from 13 or 12 years for "light work". The minimum age for hazardous work — work that is likely to harm the health, safety or morals of the child as a consequence of its nature or the circumstances under which it is carried out — is 18 years for all countries (see Table G.1).

The term "child labour" should not be confused with "youth employment" or "student work", which may be both legitimate and desirable if performed as part of a genuine apprenticeship or training programme that complies with applicable laws and regulations.

Table G.1 — Minimum ages for work

Type of work	Developed countries	Developing countries
Regular work	At least 15 years	At least 14 years
Hazardous work	18 years	18 years
Light work	13 years	12 years

Annex H
(informative)

Greenhouse gas

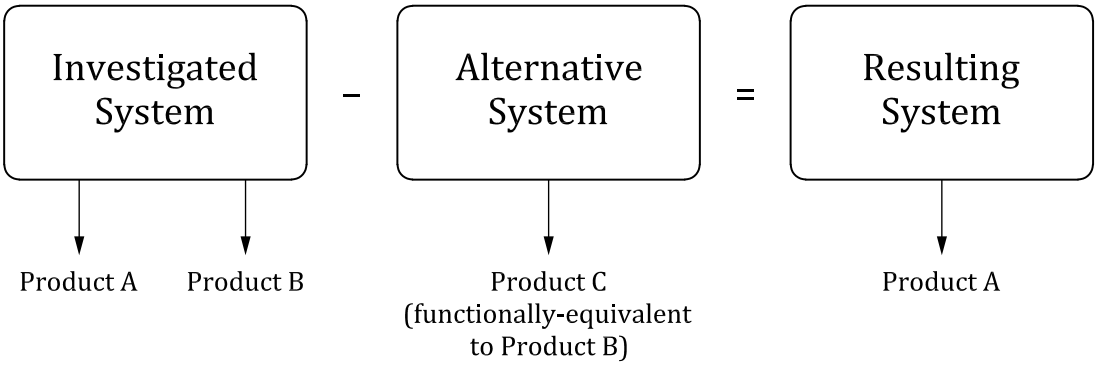
H.1 General

This annex provides additional information which can be useful for to understand GHG assessments.

H.2 System expansion

The procedure for system expansion varies depending on whether the bioenergy product is the main product of the multi-output product system under study (see Figure H.1), or another co-product that is not the main product of the production process (see Figure H.2).

In cases where the bioenergy product (Product A) is the main product, system expansion involves expanding the modelling of the multi-output product system under study to include the fate of the other co-product (Product B). To determine the GHG emissions and removals of the bioenergy product (Product A) alone, the total GHG emissions and removals of the multi-functional activity (Products A and B) are included and the GHG emissions and removals of a displaced alternative product (Product C) are subtracted. Figure H.1 provides a visual example for system expansion when the main product is an energy product.



NOTE Adapted from ISO 14041:1998[1)].

Figure H.1 — System expansion when the main product is an energy product

In cases where the main product (Product D) is a non-energy product, and the other co-product (Product E) is used for bioenergy, the superseded use of that co-product (Product E) will be met by an alternative product (Product F). Therefore the effect of diverting the other co-product (Product E) to bioenergy is quantified as the GHG emissions and removals of the life cycle of that alternative product (Product F). Figure H.2 provides a visual example for system expansion when the main product is not an energy product.

1) Withdrawn.

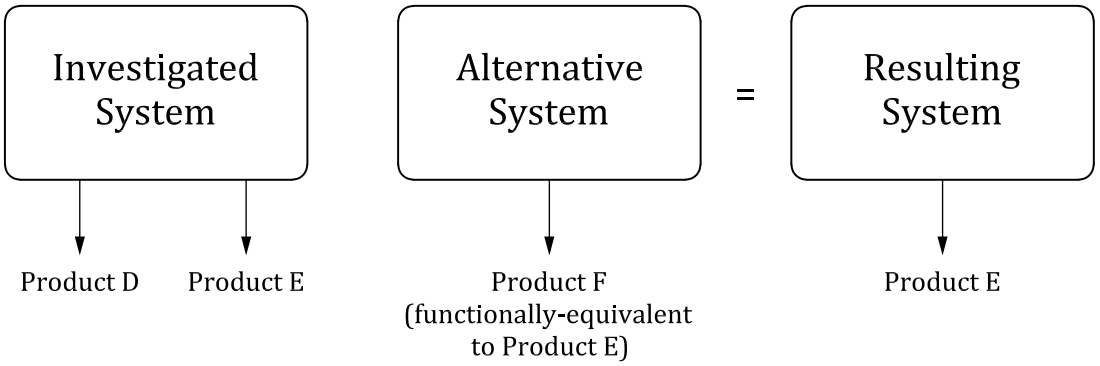


Figure H.2 — System expansion when the main product is a non-energy product

Selection of the displaced product requires identification of the marginal supply of a functionally-equivalent product. The procedure for system expansion including the selection of the functionally-equivalent product should be documented and justified, with consideration of market factors that influence displacement by the co-product.

The method of avoiding allocation by expanding the system boundaries requires that the alternative product is known and data are available for both product systems.

H.3 Tables of bioenergy and fossil energy pathways and life cycle stages for each

Table H.1 provides some examples of energy pathways. Table H.1 illustrates the multiplicity of feedstocks, products and uses. It is meant to assist in evaluating which comparisons of energy options are most relevant for the purpose of a given study.

Table H.1 — Examples of bioenergy and fossil energy pathways

Energy source	Feedstock	Fuel	Energy Use
Bioenergy source	Sugar (e.g. cane, beet)	Ethanol or /gasoline	Transportation
	Starch (e.g. corn, wheat, cassava)	Ethanol, gasoline	Transportation
	Oil (e.g. animal fats, waste fat oils, soybean, palm oil, rapeseed, used cooking oil, jatropa and algae)	Biodiesel, FAME, heating oil, diesel	Transportation and heating
	Cellulose (e.g. straw, wood, perennials)	Ethanol, butanol, gasoline, diesel, heating oil or jet fuel, solid bioenergy (e.g. pellets and wood chips) and methane	Transportation, heating and power
	Organic material (e.g. effluent, sludge, municipal waste, food waste)	Methane/ electricity, heating oil	Transportation, heating and power
Fossil energy source	Crude oil (e.g. conventional, oil sands)	Gasoline, diesel, heating oil	Transportation, heating and power
	Natural gas, shale gas	Compressed natural gas, liquefied natural gas, Fischer-Tropsch liquids	Transportation
	Natural gas and crude oil	Liquefied petroleum gas	Transportation
	Coal	Fischer-Tropsch liquids	Transportation
	Coal	Electricity	Transportation and power

Table H.2 provides an overview of the life cycle stages to be included in GHG quantifications. In addition, it shows examples of typical activities for the various life stages. The purpose of Table H.2 to is to assist in evaluating whether two life cycles are equivalent for the purpose of comparison.

Table H.2 — Life cycle stages to be included in a GHG evaluation

Life-cycle stages	Examples of data requirements for bioenergy	Examples of data requirements for fossil energy
Feedstock exploration and development	Logging roads into a forest	Exploration for fossil feedstock
	Creation of algae ponds	Drill and develop oil or gas well
	Land conversion	Gain access to coal deposit
		Development of coal mines
		Land use change for surface disturbance for oil sands, coal mines
		Land clearing for seismic activity, drill pads, pipeline right of way
Production of feedstock	Tillage of farm land	Primary petroleum extraction
	Site preparation for planting	Enhanced oil recovery
	Crop planting	Natural gas extraction and processing
	Crop harvesting	Shale gas extraction and processing
	Algae cultivation	Gas flaring and venting in oil fields
	Forest management	
	Forest collection	
	Soil management	
	Application of fertilizers and pesticides	
Transportation of feedstock	Distance and mode of transportation (includes truck, rail, marine, pipeline)	Distance and mode of transportation (includes truck, rail, marine, pipeline)
Processing of feedstocks to finished energy product	Feedstock conversion	Feedstock conversion
Transportation and distribution of finished energy product	Distance and mode of transportation and distribution (includes truck, rail, marine, pipeline, refilling, transmission line)	Distance and mode of transportation and distribution (includes truck, rail, marine, pipeline, refilling, transmission line)
Use	Combustion, heat, light and power	Combustion, heat, light and power
End of life	Decommissioning of infrastructure and site rehabilitation	Decommissioning of infrastructure and site rehabilitation

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